American Journal of Industrial Medicine 28:591–602 (1995)

Back Pain Among Workers in the United States: National Estimates and Workers at High Risk

How-Ran Guo, MD, MPH, ScD, Shiro Tanaka, MD, Lorraine L. Cameron, PhD, Paul J. Seligman, MD, MPH, Virginia J. Behrens, MS, Jiin Ger, MD, Deanna K. Wild, MS, MBA, and Vern Putz-Anderson, PhD

Back pain accounts for about one fourth of workers' compensation claims in the United States. The Occupational Health Supplement to the 1988 National Health Interview Survey provided an opportunity to assess the scope of this problem. The 30,074 respondents who worked in the 12 months before the interview were defined as "workers", and those with back pain every day for a week or more during that period were defined as "cases." A weighting factor was applied to the answers to derive national estimates. In 1988, about 22.4 million back pain cases (prevalence 17.6%) were responsible for 149.1 million lost workdays; 65% of cases were attributable to occupational activities. For back pain attributed to activities at work, the risk was highest for construction laborers among males (prevalence 22.6%) and nursing aides among females (18.8%). Our analyses show that back pain is a major cause of morbidity and lost production for U.S. workers and identifies previously unrecognized high risk occupations, such as carpenters, automobile mechanics, maids, janitors, and hairdressers, for future research and prevention. © 1995 Wiley-Liss, Inc.*

Key words: back pain, occupation, industry, construction, nursing, carpenter, automobile mechanics, maid, janitor, hairdresser

INTRODUCTION

Back pain is the most frequently filed workers' compensation claim in the United States. About one fourth of workers' compensation claims are filed for back injuries [Klein et al., 1984; National Council on Compensation Insurance, 1993], and about one-third of workers' compensation costs are paid as a result of back pain claims [Labar, 1992; Webster et al., 1993]. In 1979, the direct compensation cost for

Surveillance Branch, Division of Surveillance, Hazard Evaluation and Field Studies, National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention (H.-R.G., S.T., L.L.C., P.J.S., V.J.B., J.G.).
Epidemic Intelligence Service, Centers for Disease Control and Prevention (H.-R.G.).
Support Services Branch, Division of Surveillance, Hazard Evaluation and Field Studies, National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention (D.K.W.).
Applied Psychology and Ergonomics Branch, Division of Biomedical and Behavioral Science, National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention (V.P.-A.).
Address reprint requests to Dr. How-Ran Guo, University of Cincinnati, P.O. Box 670056, 3223 Eden Avenue, Cincinnati, OH 45267-0056.
Accepted for publication March 6, 1995.

back pain was more than $1 billion [Klein et al., 1984], and the total cost of back pain was about $16 billion in 1984 [Holbrook et al., 1984], and $50 to $100 billion in 1990 [Frymoyer and Cats-Baril, 1991].

Several studies have attempted to generate national estimates of back pain [Klein et al., 1984; Cunningham and Kelsey, 1984; Deyo and Tsui-Wu, 1987; Leigh and Sheetz, 1989; Frymoyer and Cats-Baril, 1991; National Council on Compensation Insurance, 1993]. However, most did not provide detailed information by occupation due to the small study populations or the study designs. In 1988, a nationwide personal interview survey was conducted by the National Center for Health Statistics (NCHS) to assess the national scope of work related health conditions including back pain. The objective of this paper is to use the data gathered from this survey to estimate the magnitude of the back pain problem, describe the high-risk workers, and identify unrecognized high-risk occupations.

MATERIALS AND METHODS

The National Health Interview Survey (NHIS) is a continuous personal interview survey conducted by NCHS on a probability sample of the households of noninstitutionalized civilians living in the United States. Each individual selected for interview represents a number of people in the U.S. population with the same demographic characteristics. Through applying a weighting factor to the responses based on the number of people being represented by each interviewee, national estimates were generated. The weights also adjust for nonresponse. Detailed information about the survey is provided in the NCHS documentation [Adams and Hardy, 1989; Massey et al., 1989].

In the 1988 NHIS, an Occupational Health Supplement (NHIS-OHS) was sponsored by the National Institute for Occupational Safety and Health (NIOSH) and the Bureau of Labor Statistics (BLS) to study certain occupational diseases and conditions including back pain. Among the 50,061 households sampled for the 1988 NHIS, 47,485 of them participated. From each family living in the participating households, one member aged 18 years or older was randomly selected to be interviewed for the NHIS-OHS; no proxy respondent was accepted. Among the 48,365 eligible candidates for NHIS-OHS, 44,233 (91.5%) interviews were completed.

Among the respondents, 30,074 who worked any time at a job or business during the 12 months before the interview were defined as "workers." A "job or business" does not include work around the house but includes unpaid work in a family business or farm. A "back pain case" was defined as an interviewee who answered "Yes" to the question "At any time during the past 12 months, that is since (a specific date) a year ago, did you have back pain every day for a week or more?" To be counted as a case, women under age 50 must also answer "No" to the question "Did you have this back pain only at the time of your monthly periods?" In this analysis, work-related back pain was defined as back pain brought on by repeated activities or resulted from a single accident or injury at work, and this information was self-reported without confirmation by medical records.

The survey data were analyzed using Software for Survey Data Analyses (SUDAAN), designed for analysis of data from complex multistage surveys [Research Triangle Institute, 1990]. As recommended by NCHS, all statistical analyses

were weighted to represent the U.S. population [Massey et al., 1989]. Accordingly, the results reported in this paper represent the national estimates in the United States.

The occupation of each respondent in the 12 months before the interview was coded as one of the 502 occupation categories using the 3-digit 1980 Bureau of the Census (BOC) occupation codes [Bureau of the Census, 1982]. For convenience, these occupation categories are referred to as "occupations" in this paper. The prevalence of work-related back pain in each occupation was approximated using the ratio of the estimated number of cases attributing their back pain to an occupation to the estimated total number of workers in that occupation. The number of cases attributing their back pain to an occupation was approximated by the number of cases who reported performing the activities that caused back pain when they were in that occupation; such information was gathered in the Back Pain Section of the questionnaire [Park et al., 1993]. The total number of workers in an occupation was approximated by the number of workers who reported working in that occupation during the 12 months before the interview, based on the assumption that the number of workers in each occupation remained constant over the whole study period; such information was gathered in the Work History Section of the questionnaire. To ensure stable estimates, our analyses were focused on the major occupations only. A "major occupation" was defined as an occupation constituting more than 0.5% (an arbitrarily assigned cut point to choose the focuses of our analyses) of the total working population estimated by the NHIS-OHS. Accordingly, out of 502 occupations coded by BOC, there were 49 major occupations for males (each had more than 349,000 estimated male workers) and 45 major occupations for females (each had more than 290,000 estimated female workers). A relative risk for each occupation was approximated by the prevalence ratio as compared to all male or female workers. The occupations with a prevalence ratio above 1.0 were considered "high risk."

To evaluate how well the high-risk occupations identified by NHIS-OHS have been studied in the past, we conducted a review of literature on back pain in NIOSHTIC, a publicly available computerized occupational safety and health data base maintained by NIOSH. Using "back pain," "back injury," and "back injuries" as key words, we searched for papers reporting studies on high-risk occupations. Among 859 abstracts and papers reviewed, 248 identified the study population by occupation and focused on one or several occupations. The occupations studied by each paper were coded with BOC occupation codes; some papers contributed to more than one occupation.

RESULTS

National Estimates

Among the 30,074 "workers" interviewed, 5,256 back pain cases were observed, representing 22.4 million cases and a prevalence of 17.6% (SE = 0.3%) during the 1-year period. Based on the number of lost workdays reported by interviewees, we estimated that a total of 149.1 million workdays were lost during the 1-year period by the cases as defined. About 12.1% of cases (2.1% of all workers, SE = 0.1%) recalled ever stopping working at a job or changing jobs because of back pain during their entire working career. In addition, about 9.6% of cases (1.7% of all workers, SE = 0.1%) recalled ever making a major change in their work activities

TABLE I. Number of Cases and Prevalence of Back Pain by Age and Gender: United States, 1988 NHIS

	Male cases		Female cases		
Age (year)	(n = 1,000)	Prevalence (SE)[a] (%)	(n = 1,000)	Prevalence (SE) (%)	Male/Female prevalence ratio
18–24	1,506	13.0 (0.9)	1,465	13.5 (0.8)	0.97
25–34	3,580	17.9 (0.6)	2,811	16.7 (0.7)	1.07
35–44	3,568	21.8 (0.8)	2,606	18.4 (0.7)	1.18
45–54	2,107	19.6 (0.9)	1,690	19.3 (1.0)	1.02
55–64	1,298	17.5 (1.2)	1,044	17.9 (1.0)	0.98
65–74	356	17.6 (1.7)	244	14.3 (1.7)	1.23
75–	66	14.8 (4.0)	19	6.5 (2.4)	2.28
total	12,481	18.2 (0.4)	9,879	16.9 (0.4)	1.08

[a]Standard error.

because of back pain, although they had never stopped working at a job or changed jobs due to back pain.

The age distribution of cases was similar for males and females; most of whom were 25–44 years old (Table I). More than one-half of cases (55.8%, SE = 0.8%) were males, and male workers had a higher overall prevalence than female workers (18.2% vs. 16.9%; $p < 0.05$ for the Pearson chi-square test for gender difference). However, when the age-specific estimates were compared, the statistically significant difference was observed only in the age group 35–44. The prevalence in the youngest group (18–24 years old) was lower than the overall rate but was still substantial (13.1% for males and 13.5% for females).

Among the four major racial groups, "Aleut, Eskimo, or American Indian" had the highest prevalence of back pain cases for both males (27.8%, SE = 5.9%) and females (21.1%, SE = 4.2%). "Asian or Pacific Islander" had the lowest risks (8.9% for males, SE = 1.9%; 11.7% for females, SE = 2.2%). In addition, white workers had a higher prevalence than black workers for both males (19.0%, SE = 0.4% vs. 13.5%, SE = 0.9%) and females (17.5%, SE = 0.4% vs. 13.4%, SE = 0.9%).

Among the cases, 59.8% had experienced at least one episode (back pain every day for a week or more) before 1988. One tenth of the cases (11.1% for males and 9.9% for females) had their first episode before 19 years of age, and about two-thirds of cases (69.4% for males and 65.3% for females) experienced their first episode before age 35. Very few cases had their first episode after age 54 (4.2% for males and 4.3% for females). About 40% of cases had back pain for less than a total of 30 days during the 12-month period before the interview; however, about 20% of cases had back pain every day over the whole period.

The lower back was identified by three-fourths of cases (78.0% for males and 70.4% for females) as the part of back that bothered them most. Although the upper and middle back were about equally involved among male cases (about 10.5% each), female cases had more upper back pains than middle back pains (16.6% vs. 11.5%).

More than three-fourths of cases attributed the cause of their back pain to "activities," including 35.6% to "repeated activities," 21.4% to "a single accident or injury," and 20.7% to both (Table II). Other self-reported causes of back pain

TABLE II. Number and Proportion of Back Pain Cases by Self-Reported Causes and Gender: United States, 1988 NHIS[a]

Cause of back pain	Male cases		Female cases		Total cases	
	(n = 1,000)	%	(n = 1,000)	%	(n = 1,000)	%
Repeated activities (R) only	4,718	37.8	3,239	32.8	7,957	35.6
(at work)	(3,614	29.0)	(2,208	22.4)	(5,822	26.0)
Single accident or injury (A)	2,808	22.5	1,981	20.1	4,789	21.4
only (at work)	(1,252	10.0)	(513	5.2)	(1,765	7.9)
Both (R) and (A)	2,952	23.7	1,684	17.0	4,636	20.7
(at work)	(2,454	19.7)	(1,218	12.3)	(3,672	16.4)
Disease/disorder	670	5.4	1,002	10.2	1,673	7.5
Pregnancy	—	—	478	4.8	478	2.1
Other	389	3.1	473	4.8	862	3.9
Unknown	944	7.6	1,021	10.3	1,965	8.8
Total	12,481	100.0	9,878	100.0	22,359	100.0

[a]Cases numbers rounded off to 1,000, and percentages rounded off to the first decimal.

contributed relatively few cases, and 8.8% of cases were unable to identify the cause of their back pain. A higher proportion of male cases attributed their back pain to activities as compared with female cases (84.0% vs. 69.8%). Among the cases who attributed their back pain to repeated activities, 73.2% (5,822,000/7,957,000) performed the activities at work. In contrast, only 36.9% (1,765,000/4,636,000) of the cases who attributed their back pain to a single accident or injury were work related. Altogether, about one-half (50.4%; 11,259,000/22,359,000) of all back pain cases were work related. The prevalence of work related back pain was 8.9% (SE = 0.2%), and male workers had higher prevalence than female workers (10.7% vs. 6.7%; $p < 0.01$ for the Pearson chi-square test for gender difference).

High-Risk Occupations

Among male workers, the 49 major occupations accounted for 57.8% of work-related back pain cases, and the top 15 high-risk occupations accounted for 29.0%. The highest risk major occupation for work related back pain was "Construction Laborers" (relative risk in terms of prevalence ratio as compared to all male workers = 2.1), whereas "Carpenters" had the largest number of cases (392,000) (Table III). Among female workers, the 45 major occupations accounted for 62.4% of the work-related cases, and the top 15 accounted for 37.8%. The highest-risk occupation was "Nursing Aides, Orderlies, and Attendants" (relative risk 2.8), and they also had the largest number of cases (269,000) (Table IV).

The major occupations in which male and female workers engaged were different, and the risk of work-related back pain in the same occupation was also sometimes different between males and females. For example, "Farmers, except horticultural" was the fifth highest risk major occupation for males with a prevalence of 18.8%, but it was ranked the twentieth for females with a prevalence of 7.0%. By contrast, the risk of work-related back pain in some occupations was not significantly different between males and females. For example, "Janitors and Cleaners" was the 22nd highest risk major occupation for males with a prevalence rate of 12.2%, and fourth among females with a prevalence of 13.3%. This might be due to the fact that

TABLE III. Top 15 High-Risk Occupations for Back Pain Attributed to Activities at Work in Males Among the 49 Major Occupations With More Than 349,000 Male Workers in 1988

Occupation (Bureau of Census Occupation Code)	Cases	Prevalence	(SE) %	R.R.[a]
Construction Laborers (869)	159,000	22.6	(4.3)	2.1
Carpenters (567)	392,000	22.2	(2.3)	2.1
Industrial Truck and Tractor Equipment Operators (856)	110,000	21.8	(5.2)	2.0
Automobile Mechanics (505)	189,000	19.3	(3.1)	1.8
Farmers, except horticultural (473)	213,000	18.8	(2.9)	1.8
Construction Supervisors, not elsewhere classified (558)	99,000	18.7	(4.1)	1.7
Plumbers, Pipefitters, and Steamfitters (585)	101,000	18.4	(4.2)	1.7
Industrial Machinery Repairers (518)	83,000	18.3	(4.6)	1.7
Stock Handlers and Baggers (877)	74,000	17.8	(4.8)	1.7
Truck Drivers, heavy (804)	362,000	17.7	(2.2)	1.7
Farm Workers (479)	102,000	17.3	(4.5)	1.6
Groundskeepers, and Gardeners, except farm (486)	120,000	17.1	(3.7)	1.6
Truck Drivers, light (805)	107,000	16.8	(3.5)	1.6
Welders and Cutters (783)	104,000	16.7	(3.8)	1.6
Laborers, except construction (889)	190,000	16.4	(2.7)	1.5

[a]Prevalence ratio compared to the prevalence of all male workers: 10.7%, SE = 0.4%.

TABLE IV. Top 15 High-Risk Occupations for Back Pain Attributed to Activities at Work in Females Among 45 Major Occupations With More Than 290,000 Female Workers in 1988

Occupation (Bureau of Census Occupation Code)	Cases	Prevalence	(SE) %	R.R.[a]
Nursing Aides, Orderlies, and Attendants (447)	269,000	18.8	(2.5)	2.8
Licensed Practical Nurses (207)	99,000	16.3	(3.5)	2.4
Maids (449)	84,000	14.9	(3.2)	2.2
Janitors and Cleaners (453)	102,000	13.3	(2.9)	2.0
Laborers, except construction (889)	46,000	12.8	(3.8)	1.9
Hairdressers and Cosmetologists (458)	91,000	12.5	(7.6)	1.8
Production Inspectors, Checkers, and Examiners (796)	44,000	11.8	(3.8)	1.8
Designers (185)	45,000	11.8	(3.3)	1.7
Health Aides, except nursing (446)	39,000	11.1	(4.0)	1.6
Waiters and Waitresses (435)	147,000	10.8	(1.8)	1.6
Registered Nurses (095)	174,000	10.4	(1.8)	1.5
Cooks, except short order (436)	89,000	9.5	(2.0)	1.4
Textile Sewing Machine Operators (744)	60,000	9.1	(2.6)	1.3
Teachers, not elsewhere classified (159)	27,000	8.2	(4.4)	1.2
Cashiers (276)	175,000	8.1	(1.4)	1.2

[a]Prevalence ratio compared to the prevalence of all female workers: 6.7%, SE = 0.2%.

the work activities are quite different between males and females in some occupations but quite similar in other occupations.

The review of NIOSHTIC showed that most of the studies on back pain or back injury were targeted at high-risk occupations, most frequently at "Nursing Aides, Orderlies, and Attendants" (68 studies). Based on the estimated prevalence in our study, all five most frequently studied occupations (Nursing Aides, Orderlies, and Attendants; Registered Nurses; Licensed Practical Nurses; Mining Machine Operators; and Construction Laborers) were high-risk occupations, except "Registered Nurses" (Table V). "Registered Nurses" might have received considerable lot of attention, as many studies studied "Nursing Aides, Orderlies, and Attendants,"

TABLE V. Most Frequently Studied Occupations by Studies on Back Pain in NIOSHTIC Data Base

Occupation (Bureau of Census Occupation Code)	Study No.[a]	Case No.[b]	Risk ranking	
			Males	Females
Nursing Aides, Orderlies, and Attendants (447)	68	288,000	NR[c]	1
Registered Nurses (095)	66	181,000	NR	11
Licensed Practical Nurses (207)	60	99,000	NR	2
Mining Machine Operators (616)	26	4,000	NR	NR
Construction Laborers (869)	15	163,000	1	NR
Airplane Pilots and Navigators (226)	13	0	NR	NR
Truck Drivers, heavy (804)	13	376,000	10	NR
Industrial Truck and Tractor Equipment Operators (856)	13	120,000	3	NR
Farmers, except horticultural (473)	9	234,000	5	20
Truck Drivers, light (805)	8	106,853	13	NR
Bus Drivers (808)	8	44,000	NR	NR

[a]Based on NIOSHTIC data base, 1992.
[b]Males and females combined.
[c]NR: not ranked; not among the 49 major occupations for males and 45 major occupations for females.

"Registered Nurses," and "Licensed Practical Nurses" as a group; altogether, these three occupations attracted 78 studies. On the other hand, among the top five high-risk occupations for males identified in this analysis, "Construction Laborers," "Industrial Truck and Tractor Equipment Operators," and "Farmers, except horticultural" had attracted comparable numbers of studies, but there were only two studies on "Carpenters" and one on "Automobile Mechanics." Among the high-risk occupations of females, "Nursing Aides, Orderlies, and Attendants" and "Licensed Practical Nurses" had received considerable attention, but there was only one study on "Janitors" and no studies on "Hairdressers" or "Maids." "Laborers, except construction," the fifth highest risk major occupation for females, was not discussed because it was defined by exclusion, not inclusion, and thus was a relatively diverse group of workers in terms of occupational activities and other risk factors of back pain.

DISCUSSION

National Estimates

The NHIS-OHS data confirm back pain as a major health problem among U.S. workers with about 22.4 million cases and a prevalence of 17.6% in 1988. The results are comparable to the findings from the Quality of Employment Survey (QES) conducted in 1973 on a national random sample of full-time workers, in which about 19.8% of the respondents answered "Yes" to the question "Have you had trouble with your back or spine in the past year?" (no limitation on duration included in the case definition) [Leigh and Sheetz, 1989]. However, a study based on 1979 workers' compensation claims from 26 states found only 0.75 claims per 100 workers for back strains of sprains and 0.86 claims per 100 workers for back injuries [Klein et al., 1984]. Workers' compensation data may underestimate the impact of back pain because claims qualifying for compensation may not include all cases resulting in

TABLE VI. Published Estimates of Annual Occurrence of Back Pain Among Workers

Ref[a]	Condition	Occurrence	Data sources	Study time	Population
1	Back pain lasting over a week	17.6% prevalence	50 states, U.S.	1988	30.074[b]
2	Compensated back injury	0.87 claim/100 workers	26 states, U.S.	1979	38,250,100[c]
3	Back/spine trouble	20% prevalence	50 states, U.S.	1973	1,414[b]
4	Back pain	20% prevalence (males)	United Kingdom	1986	2,684[b]
5	Low back pain	8% prevalence	Denmark	1982	6,000[b]
6	Compensated back injury	0.29% incidence	Sweden	1980	4,051,000[c]
7	Compensated back injury	3.28 claims/100 workers	New Zealand	1984	63,000[c]
8	Compensated back injury	1.7% incidence	Quebec, Canada	1981	2,588,930
9	Absence from work due to back pain	1.37% prevalence	Quebec, Canada	1981	2,719,545

[a]Reference: 1, NHIS-OHS [1988]; 2, Klein et al. [1984]; 3, Leigh and Sheetz [1989]; 4, Anderson [1986]; 5, Svane [1987]; 6, Broberg [1984]; 7, Burry and Gravis [1988]; 8, Gervais and Hébert [1987]; 9, Abenhaim and Suissa [1988].
[b]Representative sample of the general working population.
[c]Estimated from the data provided in the paper.

costs or lost productivity, and some patients meeting the criteria for compensation may never be compensated for various reasons. One report indicated that about 50% of those who had experienced a back pain episode did not seek medical care [Reisbord and Greenland, 1985], and another report estimated that only about 10% of low back pain episodes were ultimately awarded workers' compensation [Chaffin, 1979]. Therefore, compensated cases are a relatively small part of all back pain patients and are not likely to be representative of all workers with back pain.

In comparison with workers, the general population has a somewhat lower risk of back pain. Based on data from the First U.S. Health and Nutrition Examination Survey (HANES-I), the prevalence of self-reported back pain in a 1-year period for persons aged 25–74 years was about 13.8–15.5% [Cunningham and Kelsey, 1984]. In a similar survey (HANES-II) conducted later, the prevalence of low back pain lasting at least 2 weeks was estimated to be 10.3% in a 1-year period and 13.8% in the lifetime [Deyo and Tsui-Wu, 1987].

Back pain is a major occupational health problem in many countries [Anonymous, 1976; Svensson and Andersson, 1983, 1989; Broberg, 1984; Anderson, 1986; Svane, 1987; Gervais and Hebert, 1987; Abenhaim and Suissa, 1987, 1988; Burry and Gravis, 1988; Stubbs, 1991]. However, due to different case definitions and outcome measurements, it is often difficult to compare study results (Table VI). Nonetheless, it is obvious that back pain is very common among workers in many countries and accounts for a large number of lost workdays and substantial costs.

Since about 12.1% of the cases in the survey reported to have stopped working at a job or to have changed jobs due to back pain, the life-time prevalence of such changes among all workers was estimated to be 2.1% (17.6% × 12.1%). This is probably an underestimation because the question was asked of the cases only, and workers may stop working or change jobs due to back pain without any episode lasting for a week or more during the previous year. This is also true in estimating the

prevalence for staying in the same job but making a major change in work activities. In the HANES-I, 16.3% of the back or neck pain cases reported changes in their job status because of these conditions over a 5-year period [Cunningham and Kelsey, 1984].

The male predominance in total number of cases was observed in both surveys of self-reported back pain [National Council on Compensation Insurance, 1993], including NHIS-OHS, and the workers' compensation study [Klein et al., 1984]; however, it was more prominent in the latter (55.8% of self-reported cases in NHIS-OHS vs. 76% of compensable back strains or sprains cases). This change over time might reflect the fact that proportionately more females have joined the work force in recent years [Bureau of the Census, 1993]. Although workers' compensation data indicated that male workers had twice the risk of female workers [Klein et al., 1984], NHIS-OHS and an earlier self-reported survey (QES) showed similar prevalence between male and female workers [Leigh and Sheetz, 1989]. Factors such as case definitions, severity of back pain, and insurance coverage might also contribute to these differences.

Although the high-risk age group identified by this study is 35–44 for male workers and 45–54 for female workers, the high-risk age group identified in QES was 50–64 [Leigh and Sheetz, 1989]. The differences in risks among these age groups were not statistically significant in either survey, and different case definitions may explain part of the observation. In addition to an estimated 13% prevalence for the youngest age group (18–24), NHIS-OHS also showed that more than two-thirds of all cases had their first episode of back pain every day for a week or more by the age of 35 years, similar to the result in a review by Chaffin [1979]. For compensable back strains or sprains, the highest risk was 20–24 years of age for males and 30–34 years for females [Klein et al., 1984]. We can, therefore, conclude that back pain is not a health problem limited to the older workers. In the general population, HANES-I showed a higher prevalence of back pain among females and a consistent increase in risk with age in both genders [Cunningham and Kelsey, 1984].

Our analysis showed higher risk of back pain among white workers for both male and female workers, but QES reported a higher risk for nonwhite workers in comparison with white workers (24.2% vs. 19.4%) [Leigh and Sheetz, 1989]. In addition to differences in case definition, possible changes of work activities within the racial groups over the 15 years between the two surveys, such as more white workers in high-risk occupations or more nonwhite workers in low risk occupations, might also contribute to the difference. In HANES-I (on general population), whites showed a slightly higher risk of back pain than that of nonwhites [Cunningham and Kelsey, 1984].

High-Risk Occupations

The review of NIOSHTIC indicated that previous studies of back pain were focused on a few occupations, especially nursing staff. The high incidence of back pain among these workers is, of course, one of the major reasons they attracted studies. However, high risk alone is not sufficient, because some of the top five high-risk occupations identified in NHIS-OHS had received little or no attention at all. In the case of the nursing staff, completeness of insurance coverage, convenience of approaching a large number of employees at one work site (e.g., a hospital), more awareness of health problems, higher expectations of health status, and the willing-

ness to participate in a health study may facilitate conduct of the surveys. By contrast, previously unrecognized high-risk occupations, such as carpenters, hairdressers, automobile mechanics, janitors, and maids, tend to have more workers employed by small businesses or self-employed. These workers may have less workers' compensation coverage, excluding them from studies based on workers' compensation claims, and they are less accessible in large numbers, making epidemiologic studies difficult and expensive to conduct. Furthermore, when a broader occupational classification is used, the high risks of some occupations may be "diluted" by the lower risks of other occupations in the same broad category.

Nonetheless, when these less-recognized high-risk occupations were studied, the risks of back pain were often found to be high. A study of 696 Finnish carpenters showed that 23% of them frequently had low back pain [Riihimaki et al., 1989], and a study in this country estimated an average of 0.9–1.2 back injuries per 100 carpenters per year requiring a visit to the hospital emergency department [Waller et al., 1989]. High incidence of back injury has been noted in the hotel industry as a whole [State of New York Workmen's Compensation Board, 1973], and several high-risk tasks for cumulative trauma disorders, including back pain, were recently identified among hotel housekeepers [Keyserling and Brouwer, 1993; Brouwer and Keyserling, 1993]. In addition, the cumulative incidence of back pain among cleaners was about 71% for workers aged 38–49 and 77% for workers aged 50–64 [Svensson and Andersson, 1983].

Strength and Limitations of the Study

Although the NHIS-OHS provides the most detailed occupation classification to date for the back pain cases, the unique case definition used makes its results difficult to compare with those from other studies. In fact, four different case definitions were used in the four national questionnaire surveys, including the NHIS-OHS [Cunningham and Kelsey, 1984; Deyo and Tsui-Wu, 1987; Leigh and Sheetz, 1989]. Also, the results from workers' compensation studies are not comparable to those from questionnaire surveys. Even on the basis of NHIS-OHS data, different estimates will be obtained with a different case definition. For example, in an analysis limited to back pain caused by activities on the most recent job [Behrens et al., 1994], the number of cases due to repeated activities was estimated to be 4.75 million in contrast to the estimate of 5.822 million (Table II), which includes all back pain cases attributable to repeated activities at work.

Because many questions in the questionnaire were limited to cases only, few data are elicited from back pain patients who had no episodes lasting a week or more during the past 12 months before the interview. Even less information on back pain was obtained from respondents who did not work in the 12-month period (nonworkers). Consequently, this study may underestimate the impact of back pain, such as workdays lost.

In epidemiologic studies, self-reporting of disease is usually considered a less accurate measurement and is sometimes referred to as a weakness of the study. However, back pain is a self-reported condition often without any objective clinical findings, and no medical test can really refute the existence of back pain. Although some false reporting would surely be encountered, there was no incentive or threat for interviewees to give false information because the NHIS is a confidential survey. As a result, the effect of misclassification should be minimal. On the other hand, the use

of other methods, including workers' compensation claims, hospital records, or physicians' diagnoses, may lead to more misclassifications, usually false-negative, than the use of questionnaires. Therefore, self-reporting should be regarded as a strength rather than a weakness of this study and, even though there are some limitations, they are the limitations of studying back pain in general.

Our analyses showed that the health and economic impact of back pain have been previously underestimated. Nearly one-fifth of U.S. workers may suffer from an episode of back pain for a week or more during a 1-year period, and workdays lost by cases alone may cost more than $13.3 billion based on the estimated $445 median weekly earnings in 1992 [Bureau of the Census, 1993]. This study also shows that some occupations with high risk of back pain, such as carpenters, automobile mechanics, maids, janitors, and hairdressers, might not have received enough attention. More research and intervention efforts should target these workers. Since the study used in this paper (NHIS-OHS) was a one-time cross-sectional survey, we are unable to assess time trends. We hope that similar surveys will be conducted in the future to address some of the concerns suggested by this analysis. Further analysis of the risk factors for back pain based on the 1988 NHIS-OHS is currently under way.

REFERENCES

Abenhaim L, Suissa S (1987): Importance and economic burden of occupational back pain. J Occup Med 29:670–674.

Abenhaim L, Suissa S (1988): "Economic Scope of Occupationally-Induced Back Pain." Research Summary No. 66. Institute de recherche en santé et en securité du travail du Québec. Quebec: IRSST.

Adams PF, Hardy AM (1989): "Current estimates from the National Health Interview Survey: United States, 1988." Hayttsville: National Center for Health Statistics. (Vital and Health Statistics, Series 10: Data from the National Health Interview Survey, no. 173). DHHS publication no. PHS89-1501.

Anderson JAD (1986): Epidemiological aspects of back pain. J Soc Occup Med 36:90–94.

Anonymous (1976): "Low back pain and its relationship to work place factors and individual factors—review of literature, Partial Report 2." Ryggskador i Arbetslivet.

Behrens BJ, Seligman PJ, Cameron LL, Mathias CGT, Fine LJ (1994): The prevalence of back pain, hand discomfort, and dermatitis in the US working population. Am J Public Health 84:1780–1785.

Broberg E (1984): "Ergonomic Injuries at work." ISA-Information System on Occupational Injuries, Report No. 1984:3E, Swedish National Board of Occupational Safety and Health.

Brouwer ML, Keyserling WM (1993): Assessment of exposure to ergonomic risk factors in hotel housekeeping tasks. American Industrial Hygiene Conference, 1993. New Orleans, May, 1993.

Bureau of the Census (1982): "Alphabetical Index of Industries and Occupations, 1980 Census of Population, Final Edition." Washington: U.S. Department of Commerce.

Bureau of the Census (1993): "Statistical Abstract of the United States: 1993, 113th Edition." Washington: U.S. Department of Commerce.

Burry HC, Gravis V (1988): Compensated back injury in New Zealand. NZ Med J 101:542–544.

Chaffin DB (1979): Manual materials handling-the cause of overexertion injury and illness in industry. J Environ Pathol Toxicol 2:67–73.

Cunningham LS, Kelsey JL (1984): Epidemiology of musculoskeletal impairments and associated disability. Am J Public Health 74:574–579.

Deyo RA, Tsui-Wu Y-J (1987): Descriptive epidemiology of low-back pain and its related medical care in the United States. Spine 12:264–268.

Frymoyer JW, Cats-Baril WL (1991): An overview of the incidence and costs of low back pain. Orthop Clin North Am 22:262–271.

Gervais M, Hébert P (1987): "Statistical Summary of Back Injuries." Quebec: Institut de recherche en santé et en sécurité du travail du Québec.

Holbrook TL, Grazier KL, Kelsey JL, Stauffer RN (1984): "The Frequency of Occurrence, Impact, and Cost of Musculoskeletal Conditions in the United States." Chicago: American Academy of Orthopaedic Surgeons.

Keyserling WM, Brouwer ML (1993): Assessment of exposure to ergonomic risk factors in hotel housekeeping tasks. American Industrial Hygiene Conference 1993. New Orleans, May, 1993.

Klein BP, Jensen RC, Sanderson LM (1984): Assessment of workers' compensation claims for back strains/sprains. J Occup Med 26:443–448.

Labar G (1992): A battle plan for back injury prevention. Occup Hazards 11:29–33.

Leigh JP, Sheetz RM (1989): Prevalence of back pain among fulltime United States workers. Br J Ind Med 46:651–657.

Massey JT, Moore TF, Parsons VL, Tadros W (1989): "Design and Estimation for the National Health Interview Survey, 1985–1994." Hayttsville: National Center for Health Statistics. (Vital and health statistics, Series 2: Data evaluation and methods research, no. 110). DHHS publication no. PHS89-1384.

National Council on Compensation Insurance (1993): "Workers' Compensation Back Pain Claim Study." New York: National Council on Compensation Insurance.

Park CH, Wagener DK, Winn DM, Pierce JP (1993): "Health Conditions Among the Currently Employed: United States, 1988." Hyattsville: National Center for Health Statistics. (Vital and health statistics, Series 10: Data from the National Health Interview Survey, no. 186). DHHS publication no. PHS93-1514.

Reisbord LS, Greenland S (1985): Factors associated with self-reported back-pain prevalence: A population-based study. J Chron Dis 38:691–702.

Research Triangle Institute (1990): "Software for Survey Data Analysis (SUDAAN) Version 5.30." Research Triangle Park: Research Triangle Institute.

Riihimaki H, Tola S, Videman T, Hanninen K (1989): Low back pain and occupation. A cross-sectional questionnaire study of men in machine operating, dynamic physical work, and sedentary work. Spine 14:204–209.

State of New York Workmen's Compensation Board (1973): "Work Accidents in the Hotel Industry." Research and Statistics Bulletin No. 25.

Stubbs D (1991): Ergonomics and back pain. Occup Health 43:82–85.

Svane O (1987): National prevention of musculoskeletal workplace injury: Denmark—a summary. Ergonomics 30:181–184.

Svensson H-O, Andersson GBJ (1983): Low back pain in 40-to-47-year old men: Work history and work environment factors. Spine 8:272–276.

Svensson H-O, Andersson GBJ (1989): The relationship of low-back pain, work history, work environment, and stress. Spine 14:517–522.

Waller JA, Payne SR, Skelly JM (1989): Injuries to carpenters. J Occup Med 31:687–692.

Webster BS, Snook SH (1993): The cost of 1989 Workers' Compensation low back pain claims. Spine 19:1111–1126.