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To: NIOSH Docket Office (CDC); Wagner, Gregory R. (CDC/NIOSH/OD)
Cc: Stout, Nancy A. Ed.D. (CDC/NIOSH/DSR)
Subject: 132 - NIOSH WorkLife Essential Elements
Attachments: HIS Injuries work AJPH 2005 published .pdf; Injury prevention blurring home work IP 2003 Smith .pdf; Blurring the distinctions between on and off- the-job injuries similarities and differences in circumstances.pdf

Re: Essential elements of effective workplace programs and policies for improving worker health and wellbeing; draft document; 2/08 NIOSH Docket Number 034

I just saw the February 2008 draft of "Essential elements of effective workplace programs and policies for improving worker health and wellbeing; draft document: NIOSH Docket Number 034 that was recently posted to the NIOSH website.

While most of the document is excellent and well put together I was very surprised to see that there was no mention of injury prevention in the document.

The prevention of injuries on and off the job is one of the most effective strategies to improve worker health and well being and also for the health and well being of their families. All too often workplace injury prevention programs are treated as completely separate from injury prevention in the community. I strongly believe that we are missing important opportunities to link on and off-the-job injury prevention opportunities. It is the employer who bears most of the costs for treatment for injuries to workers and their families whether they occur on or off the job. This is in addition to the obvious costs of workers losing time on the job from injuries to themselves or caring for injured family members. I attach several articles of mine that provide more information on this.

Smith GS, Wellman HM, Sorock GS, Warner M, Courtney TK, Pransky GS, Fingerhut LA. Injuries at work in the US adult population: contributions to the total injury burden. *Am J Public Health.* 2005 Jul;95(7):1213-9.

Smith GS, Sorock GS, Wellman HM, Courtney TK, Pransky GS. Blurring the distinctions between on and off the job injuries: similarities and differences in circumstances. *Inj Prev.* 2006 Aug;12(4):236-41

Smith GS. Injury prevention: blurring the distinctions between home and work. *Inj Prev.* 2003 ;9:3-5

I would be happy to provide more information if desired.

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Injuries at Work in the US Adult Population: Contributions to the Total Injury Burden

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In 1997, an estimated 34.4 million medically treated injuries and poisonings occurred in the United States—a rate of 12.9 episodes per 100 persons.¹ Injuries to working-age adults, which represent an important part of this injury burden, are often overlooked despite having a larger economic impact than injuries to other age groups.² Until recently, comparable national data that distinguished work-related from non-work-related injuries were not available on the incidence and types of injuries to working-age adults. Moreover, existing workplace-based reporting systems may substantially underestimate occupational injuries.^{3–23} When adjustment is made for underreporting, annual estimates of nonfatal work-related injuries in the United States range from 6 million to 13 million.^{3,5} No comprehensive national data exist on nonfatal work-related injuries or even work-related injury hospitalizations.^{12–14}

The National Health Interview Survey (NHIS) is one of the most important tools for monitoring the health of the US population.^{24–27} It recently has been revised to improve the quality of data collected on injuries and includes work relatedness.¹ This revision now provides an opportunity to examine all injuries to adults in the US population and to assess those occurring at work, independent of workplace reporting. We used data from the redesigned NHIS for 1997–1999 to examine the contribution of nonfatal injuries at work to the total injury burden of working-age adults (aged 18–64 years).

METHODS

The NHIS is a nationwide survey conducted by the National Center for Health Statistics with trained interviewers from the Census Bureau. The survey provides health information about a nationally representative

Objectives. We estimated the contribution of nonfatal work-related injuries on the injury burden among working-age adults (aged 18–64 years) in the United States.

Methods. We used the 1997–1999 National Health Interview Survey (NHIS) to estimate injury rates and proportions of work-related vs non-work-related injuries.

Results. An estimated 19.4 million medically treated injuries occurred annually to working-age adults (11.7 episodes per 100 persons; 95% confidence interval [CI]=11.3, 12.1); 29%, or 5.5 million (4.5 per 100 persons; 95% CI=4.2, 4.7), occurred at work and varied by gender, age, and race/ethnicity. Among employed persons, 38% of injuries occurred at work, and among employed men aged 55–64 years, 49% of injuries occurred at work.

Conclusions. Injuries at work comprise a substantial part of the injury burden, accounting for nearly half of all injuries in some age groups. The NHIS provides an important source of population-based data with which to determine the work relatedness of injuries. Study estimates of days away from work after injury were 1.8 times higher than the Bureau of Labor Statistics (BLS) workplace-based estimates and 1.4 times as high as BLS estimates for private industry. The prominence of occupational injuries among injuries to working-age adults reinforces the need to examine workplace conditions in efforts to reduce the societal impact of injuries. (*Am J Public Health.* 2005;95:1213–1219. doi:10.2105/AJPH.2004.049338)

sample of the noninstitutionalized US civilian population.^{1,28,29} For each sampled household, in-person interviews are conducted with a resident adult who provides information on all household members. Information collected includes demographic and personal characteristics, health status, and use of health resources. Most analyses in this article were derived from data reported by the resident adult on behalf of all members of the family. However, to obtain the most accurate information on employment, occupation, industry, and other items, 1 adult in each household is randomly selected as the “sample” adult from whom data are gathered directly (data available as a separate sample adult file).

Beginning in 1997, more detailed information on injuries was collected by the NHIS.¹ Details concerning all medically treated injuries (including those injuries about which advice was received) during the past 3 months to any member of the household, including injuries related to any paid work, were obtained from the respondent through

a computer-assisted personal interview. Data from 1997 to 1999, the first 3 years of the redesigned survey, were combined to develop national estimates of nonfatal work-related and non-work-related injuries. The unit of analysis for the study was the injury episode; an injured person may have multiple episodes.

Injuries were defined as work related or at work if the response “Working at a paid job” was selected in answer to the question, “What were you doing when the injury happened?” Employed persons were defined as those who reported employment in a job or business during the week before the interview (regardless of whether they worked that week). It is possible that employment status changed between the time of the injury, which could be up to 3 months prior to the interview, and the week before the interview. Such a status change could result in some misclassification of employment status, but we assumed such changes to be minimal. We excluded all poisonings from

our analyses, because the NHIS asked separate questions for injuries and for poisonings and did not ascertain the work relatedness of poisonings during 1997–1999. Musculoskeletal disorders are also not included by definition.

Study Population

The working-age population was defined as persons aged 18 to 64 years. People younger than 18 years and people 65 years and older were excluded because of the small numbers of work-related injury episodes reported for these age groups ($n=19$ and 25 , respectively [unweighted]). A total of 113 614 households were surveyed by the NHIS during the 3 year-period, with an adult representative providing information for 298 388 household members; 99 357 sample adults were interviewed directly. The overall survey response rate for all ages was 90.3% in 1997, 88.2% in 1998, and 86.1% in 1999.^{29,30}

Data Analysis

The descriptive analysis was performed with SAS version 8.0 (SAS Institute Inc, Cary, NC). To derive national estimates, sample weights that accounted for the complex sample design of the survey were assigned by the National Center for Health Statistics for each respondent on the basis of the number and composition of households; these weights included adjustment for non-response.²⁹ Weights also were provided for the sample adults. The denominator population used for calculating injury rates was obtained directly from the survey.

The distribution of injuries was examined for all injury episodes by various characteristics and by work relatedness. Standard errors and 95% confidence intervals were calculated with SUDAAN software³¹ to account for the complex, multistage sample design used in the survey. Estimates with relative standard errors greater than 30% were considered unreliable. To identify contrasts between sub-populations that were both meaningful and significant, differences in injury rates and proportions were tested with a 2-sided z test at the 0.05 level of significance. Because multiple, simultaneous tests were performed, the Bonferroni method was used to provide a more conservative threshold for identifying significant differences. The trend in rates by

TABLE 1—Number, Percentage, and Rate of All Injury Episodes and Work-Related Injury Episodes Among the Working-Age Population (Aged 18–64 years), by Age, Gender, and Race/Ethnicity: National Health Interview Survey, 1997–1999

	All Injuries Annually		Work-Related Injuries Annually	
	No. in 1000s (%)	Rate per 100 Population ^a (95% CI)	No. in 1000s (%)	Rate per 100 Employed Population ^b (95% CI)
Age, y				
18–24	3807 (19.6)	14.9 (13.8, 16.1)	1088 (19.6)	6.6 (5.7, 7.5)
25–34	4858 (25.1)	12.5 (11.8, 13.3)	1561 (28.2)	5.0 (4.4, 5.5)
35–44	5191 (26.8)	11.7 (11.0, 12.5)	1401 (25.3)	3.8 (3.4, 4.2)
45–54	3576 (18.4)	10.4 (9.6, 11.1)	1069 (19.3)	3.9 (3.4, 4.4)
55–64	1961 (10.1)	8.8 (8.0, 9.6)	426 (7.7)	3.4 (2.7, 4.0)
Gender				
Male	11 189 (57.7)	13.8 (13.2, 14.4)	3863 (69.7)	5.8 (5.4, 6.2)
Female	8204 (42.3)	9.8 (9.3, 10.2)	1683 (30.3)	2.9 (2.6, 3.2)
Race/ethnicity				
White non-Hispanic	15 320 (79.0)	12.8 (12.3, 13.3)	4392 (79.2)	4.7 (4.4, 5.0)
Black non-Hispanic	2030 (10.5)	10.4 (9.5, 11.4)	542 (9.8)	4.0 (3.3, 4.7)
Hispanic	1438 (7.4)	7.9 (7.2, 8.7)	486 (8.8)	3.8 (3.3, 4.4)
Other	605 (3.1)	8.0 (6.5, 9.5)	126 (2.3)	2.3 (1.5, 3.2)
Total	19 393 (100.0)	11.7 (11.3, 12.1)	5546 (100.0)	4.5 (4.2, 4.7)

Note. CI = confidence interval.

^aAll people in the population aged 18 to 64 years regardless of employment ($n=165$ million).

^bPeople who were reported to be employed at a job or business in the week before the interview ($n=124$ million).

age group was tested by fitting a linear regression model weighted inversely to the variance of each rate. Tests of differences between estimates discussed in the text were conducted with these methods (results not shown).

RESULTS

Survey respondents reported a total of 4925 injury episodes (unweighted) among adults aged 18 to 64 years from 1997 to 1999. When weighted, these responses formed the basis of our national estimates. There were 1386 persons in the survey who were injured at work, resulting in 1422 work-related injury episodes (2.4% sustained 2 episodes during the 3-month period, and 2 people sustained 3 or more episodes).

Injury Estimates and Rates

The civilian, noninstitutionalized adult US population aged 18 to 64 years (approximately 165 million) sustained an estimated 19.4 million injury episodes annually, a rate of 11.7 per 100 persons (Table 1). About 5.5 million at-work injury episodes occurred an-

nually among the estimated 124 million people who were employed at the time of the interview, a rate of 4.5 per 100 employed persons. For men, the overall injury rate was 40% higher than the rate for women, but the work-related injury rate was double that of women. Overall injury rates decreased with age. The trend, however, was driven by the rate among men, because no trend by age was found among the rates for women (Figure 1). When stratified by gender, the rates for men were highest among those aged 18 to 24 years (Figure 1), both for all injuries (19.8 per 100) and for work-related injuries (9.2 per 100), and declined significantly by age. Non-Hispanic White adults had the highest injury rates, followed by non-Hispanic Black adults and Hispanic adults (Table 1). When the data were limited to work-related injuries, the order of the rates was the same, but the differences among racial/ethnic groups were smaller and nonsignificant. When rates were stratified by age and gender, differences in work-related injury rates by race/ethnicity persisted and were greatest among younger men (data not shown).

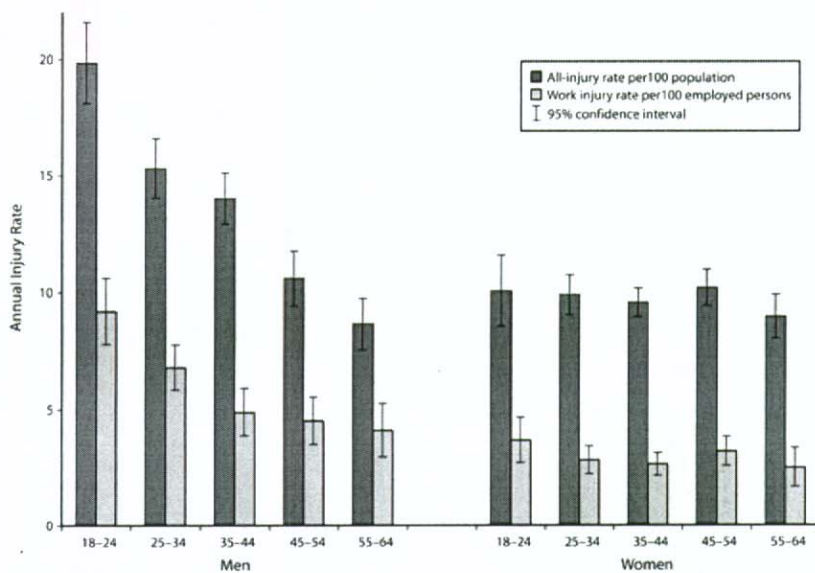


FIGURE 1—Annual rates of total injuries and work-related injuries by gender and age: National Health Interview Survey, 1997–1999.

Proportion of All Injuries That Were Work Related

Among all working-age persons, 28.6% of injuries occurred while people were working (Table 2). Annually, the employed population sustained 14.8 million injuries (data not shown), of which 37.5% occurred at work (Table 2). Among all working-age men, 34.5% of injury episodes occurred at work, compared with only 20.5% of such episodes among working-age women, with higher proportions among employed people, 42.3% and 29.7%, respectively. When data were stratified by the age of the injured person, the percentage of episodes that were work related ranged between 22% and 32%; when data were limited to employed persons, the figure was between 33% and 41%. When data were stratified by age and gender, the proportion of injuries that were work related was consistently higher for employed men than for employed women.

Nature of Injury and Body Region

For both work-related and non-work-related nonfatal injuries, sprains and strains were most common, followed by open wounds and fractures (Table 3). Crushing injuries, the presence of foreign bodies in an organ or body cavity, amputations, and burns

accounted for the highest percentages of work-related injuries. Only 17% of fractures and 18% of superficial injuries were work related. Overall, 11.3% of injury episodes (9.9% of work-related injuries and 11.8% of non-work-related injuries) were coded as *nature unspecified* (denoting that the respondent provided insufficient description of the injury to enable assignment of an *International Classification of Diseases, Ninth Revision, Clinical Modification [ICD-9-CM]*³² medical diagnosis code).

The upper- and lower-body extremities accounted for more than 60% of work-related and non-work-related injuries (Table 3). The upper extremities were involved in the largest percentage of work-related injuries, whereas for non-work-related injuries, the regions most affected were the lower extremities. Over a third of the upper-extremity injuries (36%) were work related, compared with less than a quarter of the lower-extremity injuries (23%). Fractures occurring at work were also more likely to affect an upper extremity, and non-work-related fractures were more likely to affect a lower extremity (data not shown).

Time Lost From Work

Among working-age adults, an estimated annual 8.9 million injury episodes and an esti-

mated 3.6 million work-related injury episodes resulted in at least part of a day off work. Of all injury episodes among the working-age population, 46.1% resulted in loss of at least part of a day of work, and 38.1% involved loss of 1 or more days (1–5 days lost, 21.6%; 6 or more days lost, 16.5%). Of all work-related injury episodes, 65.6% resulted in at least part of a day of lost work, and 51.0% involved loss of 1 or more days (1–5 days lost, 27.5%; 6 or more days lost, 23.6%) (data not shown).

To compare NHIS data with data from Bureau of Labor Statistics (BLS) surveys,^{6,7,15–17} which cover only private industry, we conducted separate analyses of the NHIS sample adult file; industry data were gathered only from the sampled adults. On the basis of the data from the sample adult file, 50.4% of the work-related injury episodes resulted in 1 or more days off work. Of the estimated 3.01 million annual occupational injuries resulting in at least 1 day off work reported by sample adults, 2.36 million (78.4%) were reported by employees in private industry; the remainder were reported by government employees, farm workers, or the self-employed (not included in BLS surveys).

DISCUSSION

Nonfatal injuries to working-age adults are common, annually resulting in 12 episodes of medically treated injuries per 100 adults aged 18 to 64 years. The redesigned NHIS enabled us to determine that work-related injuries are also common (4.5 episodes per 100 employed working-age persons) and are a significant part of the total injury burden; such injuries accounted for almost 30% of injuries to working-age adults, a figure that rose to almost 50% for 1 employed age group. Our ability to assess each injury recorded in the NHIS for work relatedness overcomes many of the shortcomings inherent in estimates of work-related injuries from other sources. Comparable data sources containing information on both work-related and non-work-related injuries have not been available; this lack of information has prevented an examination of the contribution of work-related injuries to the total injury burden.

TABLE 2—Percentage of Injuries That Are Work Related Among Working-Age Adults (Aged 18–64 Years), by Age, Race/Ethnicity, and Gender: National Health Interview Survey, 1997–1999

	Work-Related Injuries, %	
	Whole Working-Age Population ^a (95% CI)	Employed Working-Age Population ^b (95% CI)
Age, y		
18–24	28.6 (25.5, 31.7)	41.2 (36.8, 45.6)
25–34	32.1 (29.2, 35.0)	38.9 (35.4, 42.4)
35–44	27.0 (24.5, 29.5)	33.4 (30.4, 36.4)
45–54	29.9 (26.6, 33.2)	37.9 (33.8, 42.0)
55–64	21.7 (17.8, 25.6)	38.0 (31.7, 44.3)
Gender and age		
Male	34.5 (32.5, 36.5)	42.3 (40.0, 44.6)
18–24	31.7 (27.6, 35.8)	44.6 (39.0, 50.1)
25–34	39.9 (36.0, 43.8)	43.8 (39.5, 48.1)
35–44	31.4 (28.1, 34.7)	37.1 (33.0, 41.1)
45–54	37.0 (32.3, 41.7)	43.4 (37.8, 49.0)
55–64	30.9 (24.4, 37.4)	49.2 (39.6, 58.7)
Female	20.5 (18.5, 22.5)	29.7 (27.1, 32.3)
18–24	22.4 (17.3, 27.5)	34.0 (26.5, 41.5)
25–34	20.6 (16.9, 24.3)	29.4 (24.1, 34.7)
35–44	20.6 (17.3, 23.9)	27.5 (23.2, 31.8)
45–54	22.9 (18.6, 27.2)	31.5 (25.6, 37.3)
55–64	13.7 (9.4, 18.0)	26.2 (18.3, 34.1)
Race/ethnicity		
White non-Hispanic	28.7 (27.1, 30.3)	36.9 (35.0, 38.8)
Black non-Hispanic	26.7 (22.2, 31.2)	39.8 (33.2, 46.4)
Hispanic	33.8 (30.1, 37.5)	45.1 (40.2, 50.0)
Other non-Hispanic	20.8 (14.5, 27.1)	27.9 (19.8, 36.0)
Total	28.6 (27.2, 30.0)	37.5 (35.7, 39.3)

^aEveryone in the population aged 18–64 years regardless of employment status (n = 165 million).

^bPeople who were reported to be employed at a job or business in the week before the interview (n = 124 million).

Work-related injuries are often regarded as very different from non-work-related injuries in terms of etiology, surveillance, and prevention.¹² For instance, separate workplace-based data sources, such as BLS surveys or worker's compensation data, are used to study injuries at work.^{6,7,15–17} These sources are vulnerable to a variety of underreporting effects.^{5–7,9,10,18,19} For example, the BLS Survey of Occupational Injuries and Illnesses is the primary source of national nonfatal work-related injury data, but it covers only private industry. It excludes self-employed persons, government workers, and most workers on farms and in the informal workforce (e.g., domestic help, undocumented immigrants).^{15,16} In our study, 21.6%

of all injuries occurred among workers not covered by the BLS survey. Direct comparisons of our study with data from the BLS are possible only for cases involving lost work days, because these 2 data sources use different definitions of injury. Our NHIS-based estimate of occupational injury episodes occurring in US private industry that result in 1 or more days off work (2.36 million) was 1.4 times higher than the BLS's 1998 estimate of 1.649 million injuries that result in 1 or more days off work (i.e., excluding cases involving only restricted-duty days).¹⁶ This estimate confirms findings of previous studies that documented underreporting among the industry groups covered by the BLS.^{3–23} In addition,

the total NHIS work-related injury count for the United States (3.01 million) was 1.8 times higher than the BLS. This ratio is a function of both incomplete coverage of the US workforce by the BLS and underreporting of work-related injuries in the BLS.

Other population-based sources of occupational-injury data rely heavily on the recording of work relatedness in the medical record and may examine only 1 level of medical care. Surveys of occupational injuries with emergency department records, for example,^{5,33–35} exclude medical care provided in private physician offices and occupational health clinics. One 1988 study found that only 34% of all occupational injuries were treated in emergency departments.¹³ The reporting of work relatedness in clinical record systems is also known to be inconsistent.^{5,36} Many data sources, such as hospital discharge databases, do not systematically record work relatedness. Health care providers can play an important role in improving these data sources for occupational injury surveillance by documenting work relatedness in medical charts.

It is important to determine the work relatedness of all injuries to adults, because the type of injury usually provides little indication of whether it occurred at work. The characteristics of work-related and non-work-related injuries are similar, with little variation in distribution (Table 3). Although crushing injuries, the presence of foreign bodies, and amputations are more likely to occur at work, many such episodes occur in non-work settings. Documenting and reporting work relatedness is just as important for injuries as it is for occupational diseases.³⁷ Everyone involved in treating and preventing injuries should also evaluate work hazards, because many of the injuries occur at work, especially among working-age men.

Several earlier studies used NHIS data to examine injuries but did not compare all injuries with those occurring on the job. Warner and colleagues¹ reported that during the first year of the revised NHIS, 53% of injuries to all age groups occurred among adults aged 22 to 64 years, but they provided limited data on occupational injuries. Two recent studies examined sports and recreation injuries but did not consider whether any of these may have

TABLE 3—Nature of Injury and Affected Body Region in Work-Related and Non-Work-Related Injuries Among the Working-Age Population (Aged 18–64 Years): National Health Interview Survey, 1997–1999

	Work-Related Injuries Annually, No. in 1000s (%)	Non-Work-Related Injuries Annually, No. in 1000s (%)	% of All Injuries That Were Work Related (95% CI)
Nature of injury			
Sprains and strains	1892 (34.3)	4536 (32.8)	29.4 (26.9, 31.9)
Open wounds	1170 (21.2)	2354 (17.0)	33.2 (29.9, 36.5)
Fractures	498 (9.0)	2393 (17.3)	17.2 (14.3, 20.1)
Contusions	360 (6.5)	1197 (8.6)	23.1 (18.6, 27.6)
Dislocations	270 (4.9)	485 (3.5)	35.7 (28.4, 43.0)
Injury to internal organs	120 (2.2)	354 (2.6)	25.3 (16.5, 34.1)
Burns	183 (3.3)	251 (1.8)	42.1 (31.7, 52.5)
Superficial injuries	62 (1.1)	277 (2.0)	18.3 (9.9, 26.7)
Foreign bodies	164 (3.0)	97 (0.7)	62.9 (49.6, 76.2)
Crushing injuries	138 (2.5)	77 (0.6)	64.2 (50.1, 78.3)
Nerves	50 (0.9)	91 (0.7)	35.6 (20.5, 50.7)
Amputation of limbs	57 (1.0)	43 (0.3)	56.9 (37.5, 76.3)
Other specified ^a	... ^b (... ^b)	61 (0.4)	35.9 (15.9, 55.9)
Unspecified	548 (9.9)	1632 (11.8)	25.1 (21.2, 29.0)
Body region			
Lower extremity	1401 (25.3)	4716 (34.1)	22.9 (20.7, 25.1)
Upper extremity	2036 (36.7)	3641 (26.3)	35.9 (33.4, 38.4)
Spine and back	949 (17.1)	2140 (15.5)	30.7 (27.4, 34.0)
Face and neck	307 (5.5)	955 (6.9)	24.3 (19.4, 29.2)
Skull and brain	154 (2.8)	455 (3.3)	25.3 (17.9, 32.7)
Thorax	71 (1.3)	499 (3.6)	12.5 (7.0, 18.0)
Abdomen and pelvis	... ^b (... ^b)	54 (0.4)	38.3 (16.3, 60.3)
Other body regions	430 (7.8)	1291 (9.3)	25.0 (20.5, 29.5)
Total	5546 (100.0)	13847 (100.0)	28.6 (27.2, 30.0)

^aOther specified^a includes injuries to blood vessels, toxic effects, external causes, late effects of injuries, early complications of trauma, and medical/surgical complications.

^bEstimates are unreliable, with relative standard error of the estimate greater than 30%.

been work related.^{30,38} Prior to revision of the NHIS, most analyses considered only broad classes of injury based on 4 combinations of place and activity (i.e., home, motor vehicle, work, and other place), but these classes were not mutually exclusive.

The revised NHIS now collects data on both cause and place of injury.^{1,39} One study that used NHIS data from 1983–1987 reported higher rates of occupational injuries than in our study, as did the BLS for that period (BLS rates declined in subsequent years).¹⁶ Comparisons with NHIS data from before 1997 are not valid because of the different survey instruments used.^{40,41} Other studies have used special annual supplements to the NHIS to examine the effects of disabil-

ity and impairment in the workplace.^{27,42,43}

The 1988 Occupational Health Supplement to the NHIS included questions on work-related injury, but lack of detail on the injuries, small sample size, and problems associated with using a 1-year recall period restricted the supplement's utility in the study of workplace injuries.^{44,45}

Study Limitations

Any study relying on data from respondents may suffer from recall bias, which can result in underestimation or overestimation of injury rates.^{44,46–49} A 3-month recall period was used to increase the number of episodes of injury reported in our study.¹ Because recall improves as injury severity increases, we

enhanced recall accuracy by defining injuries as those that were severe enough to require medical attention.⁴⁷ It is possible that, in our study, home injuries were better recalled than work-related injuries because the interview took place in the home. However, we found no studies documenting such an “interview context” effect.

However, the NHIS definition of injury requires that medical attention be sought, and people injured at work may be more likely to seek medical attention than people injured at home for such reasons as improved access, compensation, and legal liability. This definition could result in the reporting of more work-related injuries than home injuries, but we were not able to address this issue in our study. Similarly, differences among recent immigrants in access to care or immigrants' reluctance to identify an injury as work related may also explain some of the observed variation by race/ethnicity. Other studies have in fact found higher rates of occupational injuries among Hispanics and Blacks, but studies across a broad range of industries have been restricted to evaluation of fatalities.^{50,51} A detailed examination of racial/ethnic differences would require careful adjustment for factors such as differences in occupational exposures and employment patterns.

Poisonings were excluded from our analyses because the activity question (asking what the person was doing when the injury occurred), which we used to define work relatedness, was not asked of those who had been poisoned until 2000. Poisonings account for less than 0.6% of all occupational injuries (from national emergency department visit data⁵²), and their exclusion is thus unlikely to have significantly altered our study findings. Owing to other questionnaire wording and survey design modifications, we did not combine the 1997–1999 estimates with more recent estimates because of concerns about comparability.⁴¹ The activity question used to define work relatedness allowed up to 2 responses. For instance, a respondent could choose “working for a paid job” and “driving or riding in a motor vehicle” as the activity being engaged in when the injury occurred. However, very few injury episodes had more than 1 activity listed, which may have resulted in underrepresentation of work relat-

edness, especially for motor vehicle injuries. Information on employment, including occupation and industry, was asked only of the sample adult, limiting our ability to conduct detailed comparisons by occupation and industry. Asking direct questions about work relatedness (e.g., whether the injury occurred during the course of paid work, or in what industry and at what occupation the injured person was working) would help to reduce the limitations of many health data systems.

Conclusions

Injuries to adults are an important public health problem that affects not only the person sustaining the injury but also other household members dependent on the injured adult for support. Injuries on the job are a significant part of this injury burden, comprising almost 30% of all medically treated injuries to adults aged 18 to 64 years. For employed men, 42% of all injuries were work related (49% among men aged 54–64 years). The NHIS is an important new source of data with which to determine the work relatedness of injuries and confirms previous studies in documenting serious underreporting by traditional workplace-based reporting systems.^{3–11} Population-based data, such as those obtained from the NHIS, provide a model for improving occupational injury surveillance and support proposals for community-oriented approaches that look at work-related and non-work-related injuries together.^{20–22} The fact that such a large proportion of injuries to working-age adults are occupational in nature also reinforces the need to examine workplace conditions in efforts to reduce the impact of injuries on society. ■

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Contributors

G. S. Smith conceived the study, supervised all aspects of its implementation, and led the writing of the article. H. M. Wellman conducted the analyses, and M. Warner assisted in calculating sample variances. All authors helped to conceptualize ideas, interpret findings, and review and revise drafts of the article.

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Human Participant Protection

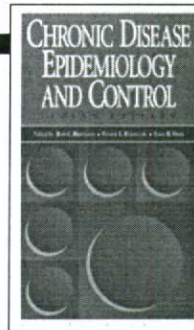
The Liberty Mutual Research Institute for Safety institutional review committee for the protection of human subjects approved the study.

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Occupational injury prevention

Injury prevention: blurring the distinctions between home and work

G S Smith

Home and work injuries share many of the same characteristics

This issue of *Injury Prevention* contains three articles about work related injury, the most for any regular issue of the journal. Their inclusion is part of the increasing recognition of occupational injury prevention as part of the mainstream injury prevention movement. It also puts the journal in the forefront as the leading multidisciplinary journal in the field of injury prevention, a direct result of the decision several years ago to expand its focus to cover all injuries, not just those to children and adolescents. Since then, in addition to the occupational injury supplement to the September 2001 issue,¹ there have been seven other work related articles covering the spectrum from hand injury prevention among sugar cutters in India to fatal electrocutions in the US.

Injuries off the job are also receiving increasing attention by industry because of their impact on the workplace, both in terms of cost and lost productivity. For example, the National Safety Council estimates that for every worker killed on the job in the US, eight workers are killed off the job at home or on the highway.² The workplace is also adversely impacted by injuries to family members. The costs of medical care and time off work to care for injured family members are largely paid for by employers, particularly when health insurance is provided through the workplace. It is estimated, for example that 63% of all unintentional injury deaths are to workers or their immediate family, most of which occur off the job. Unfortunately similar data are not available for non-fatal injuries.

NATURAL EXPERIMENTS AND INJURY TRENDS

There is wide variation in occupational injury rates by country and they are often greater than for other injuries. For example, using the United Kingdom as a benchmark, occupational fatality rates for the US and New Zealand are almost four times higher, Australia and Canada are five times higher, and Spain has a rate more than seven times that in the UK.³ The UNICEF report of child injury deaths which has been the topic of considerable discussion in this journal,⁴

however, reports only about a twofold increase in child injury fatalities over the UK rates for the same five mentioned countries (range 1.3–2.3). Differences in reporting practices that may bias these reported rates,⁵ cannot account for the huge discrepancies. Such wide variations in occupational mortality rates in relatively similar countries suggest that there is much each country can learn from the other. In fact these variations may represent opportunities to observe natural experiments based on differences in practices between countries, thus suggesting important new injury etiologies or intervention strategies.¹ However, as noted by John Langley we need detailed examination of the multiple factors that may influence cross national differences (including examining specific causes) before such studies can provide meaningful guidance for the development of prevention strategies.⁶ The Townners' recent attempt to relate differences in child injury mortality rates to differences in injury prevention legislation is a step in this direction.⁴ Similar studies have not been done for workplace injuries and could lead to an improved understanding of the effect of factors such as work place safety regulation and changes in workplace practice on reducing injuries.

Examination of temporal trends in injury rates within the same country may also provide important insights into the evaluation of previously unrecognized natural experiments. The article by Loomis *et al* in this issue, examining trends in occupational injury mortality in the US is an example of one study that goes beyond simply describing overall injury trends.⁷ While they found a 3% annual overall decline in all fatal occupational injuries in the US from 1980–96, the changes differ markedly by occupation and industry groups, gender, and by geographic region. Homicides at work showed little decline, although examination of individual differences by occupation and industry reveal more interesting findings that may suggest the effectiveness of certain prevention strategies. For example, homicide to employees at gasoline service stations declined over 5%

annually. One potential hypothesis is that most gasoline attendants now remain inside their cashier's booth and rarely venture out of their protected environment, especially at night. On the other hand, taxi drivers, who work in a much less protected environment showed a significant increase (over 3% annually) in their homicide rate. Findings such as these suggest the need for more in-depth studies to examine the specific factors that may be responsible for these discrepancies and how we can apply the findings to implement effective prevention strategies. The expanded information available in the Census of Occupational Fatalities may provide insight into these issues.⁸ In addition, most studies of mortality trends ignore the influence of improved trauma care which can reduce injury mortality, without having any influence on the actual occurrence of injury.⁹

EXPOSURE ASSESSMENT

One of the most important issues to consider when examining any changes in injury rates is variation in exposure, an essential component of evaluating injury risk.¹⁰ As acknowledged by Loomis *et al*,⁷ the use of population data, such as number of people employed, fails to recognize how risk changes by varying levels of exposure. For example, motor vehicle fatality rates per million population changed little over time, while the rates per million miles traveled decreased dramatically as a result of factors such as improved roads and vehicle crashworthiness.¹¹ In the occupational setting, exposure is more difficult to measure and hours worked is often used as a first level approximation. A comparison of population based occupational fatality rates with rates based on hours worked found that overall rankings of occupation or industry changed little in the US.¹² However, because teenagers and the elderly tend to work less than those in middle age, their risk per work hour is considerably underestimated using a population based approach.

Occupation and industry is sometimes used as a surrogate for exposure in epidemiologic studies of the workplace. However, there have been large changes in the nature of work in specific occupations and industries over time, and as Loomis *et al* discuss, they are unable to account for issues such as these in their analysis. In addition some hazardous tasks have been exported overseas. More specific measures such as hours worked on a specific task or machine would provide more accurate assessments of risk, but are beyond the scope of articles such as the one under discussion. One of our challenges is to develop better methods of assessing exposure for occupational injuries in order to better estimate task specific risks.

Driscoll *et al* in this issue make creative use of a survey of time spent on household tasks to develop exposure measures for their analysis of fatal injuries resulting from unpaid work at home, and contrast this with population based rates.¹¹ Their measures provide a much more appropriate estimate of task specific injury risk, at least for the broad categories of activities available from the survey data. The ranking of the most hazardous household tasks did not change for men, but for women household work had the highest population based risk but the lowest risk based on hours of exposure.

IMPROVING THE VALUE OF SURVEILLANCE

One important advance in the use of surveillance data to do more than count cases, is the ability to recruit cases for more in-depth study of injury causes. However, routine injury surveillance systems often lack information on work relatedness.¹ The study of nail gun injuries in residential carpenters in this issue illustrates well the value of an active surveillance program and its use to identify the factors associated with nail gun injuries.¹⁴ Despite case reports as far back as 1975 that identify problems with nail guns, they continue to cause severe injuries. The use of the National Electronic Injury Surveillance System (NEISS) to follow back on specific work related injuries,¹⁵ or for case control studies such as the effectiveness of protective gear at reducing injuries from in line skates¹⁶ are other examples of extending our use of surveillance data. The case crossover method is also well suited to in-depth follow up of injury etiology from surveillance data, as it only involves interviews of cases and estimates individual exposed person-time at risk.¹⁷

Insurance claims data also represent a potentially valuable source of cases for follow-back studies. For example, evaluating the effectiveness of child seat restraints requires data on all crashes involving children, not just those where a child is injured. Health system based studies of child seat restraints fail to capture the uninjured restrained population. A recent study enrolled a representative sample of all children involved in crashes at the time property damage claims are called into the insurance company, thus, enabling follow-back data to be collected on all crashes and their outcome.¹⁸ The use of insurance claims records for occupational injury research has been largely limited to disability and cost studies of workers' compensation claims, aside from studies such as those analyzing free text from claims.¹⁹ Studies such as the evaluation of child seat restraints using a large

insurers claims unit for subject recruitment provide a useful model for future studies.

INTEGRATION WITH LABORATORY STUDIES

One important issue not addressed by Lipscomb's article on nail guns is the need for follow up experimental studies to examine factors related to injuries and to design appropriate safety counter-measures. Their study clearly identified a problem with nail guns and the need to develop design changes. Many advances in injury prevention will come about through the integration of laboratory/experimental studies with other public health disciplines. However, often laboratory orientated articles tend to be rather technical in nature and less comprehensive in relating their findings to prior epidemiologic studies on their topic, while public health studies frequently make little reference to experimental laboratory studies or use experimental data to guide their research. One example of the value of relating experimental and epidemiological studies is the study of the role of alcohol in the workplace. While acute alcohol use rarely seems to be involved in occupational injuries,²⁰ the recent experiments using maritime shipping simulators suggest that even very low blood alcohol levels can decrease occupational performance.²¹

While the need for a collaborative multidisciplinary effort to reduce workplace injuries is well recognized, it is often difficult to implement such ideas in practice. For example, funding agencies and study sections often have difficulty evaluating multidisciplinary research proposals. Another limitation is the difficulty of appropriate information retrieval from other disciplines. While occupational injury prevention is considered interdisciplinary, all too often published researchers reference only other research from their own discipline. As noted in a recent systematic review of occupational injuries,²² many of the publications cited would not have been picked up by a search of Medline but came from non-medical disciplines and government reports that require the use of other search engines such as NIOSH-TIC, Transportation (includes TRIS), Psych INFO, and Ergonomic Abstracts. The problem may get even worse with the increasing availability of online, full text journals and the tendency to only refer to these as they are simpler (and less expensive) to access. In addition, many of the articles used in the reviews were located not by search engines, but by "pearled references" (those found hidden within other research reports), conference proceedings, and personal contacts. Increasing the links between

public health disciplines and the experimental safety sciences can only serve to strengthen the relevance of each discipline to the broader issue of improving occupational safety.

CHANGING NATURE OF WORK

An important issue in any field is definitions, and the issue of what constitutes an occupational injury has always been difficult. The article by Driscoll *et al* in this issue on fatalities from unpaid work in and around the home is a good illustration of the complexity in considering these issues.¹³ Their study provides some of the first information on unpaid work, an area of increasing interest, which has unique occupational health and safety and concerns both in developed and less developed countries.²³ In the course of reviewing coroners' records for work relatedness, the authors included unpaid home duties that could be performed for pay if done by someone else. The lead author also has a recent article in another journal that compares the classification of work relatedness for fatal injuries between Australia, New Zealand, and the US.²⁴ One key issue in defining occupational injuries is how volunteer work is counted, as illustrated in a recent study of on the job fatalities in paramedics that include volunteers who perform occupational duties for no pay.²⁵

As noted in my earlier commentary,¹ the separation between work and non-work injuries is becoming increasingly blurred, as these injuries often involve very similar mechanisms. For example, almost all the tasks involved in the unpaid work injuries fatalities described by Driscoll *et al*,¹³ such as car maintenance, ladder use and working on roofs, could also have been done for pay. In fact their increasing fatality rate in the elderly from performing these tasks suggests that maybe some of these tasks should have been hired out rather than done by the elderly homeowner. The aging of the population (including those in the workforce) presents some unique prevention challenges both at home and at work.²⁶

CONCLUSION

Some members of the injury prevention community may still consider occupational injuries to be a separate entity from other injuries and may skip over articles that seem not to be relevant to their interests. It is our hope that through the increasing profile of occupational injuries in this journal that readers will be able to learn from the cross fertilization of ideas across groups. Many of the same prevention strategies directed at occupational injuries are applicable outside the workplace, such as zero tolerance for drugs and alcohol, and use

of protective devices. In fact, the controlled environment of the workplace may represent an opportunity to evaluate some community prevention strategies such as increasing seatbelt use.¹

In today's global business environment, with its increasing number of self employed, contractual and home based workers, many workplaces are not covered by regulatory agencies such as the Occupational Safety Health Administration. The rapid growth of telecommuting, for example, presents some unique health and safety challenges.²⁷ Given the changing nature of the workplace, a new, comprehensive community approach to injury prevention is needed, one which takes into account the blurring of the lines between work and non-work environments that is increasingly prevalent in society.^{28,29} It is important that we explore all the options at home and at work to reduce the global burden of injuries.

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Blurring the distinctions between on and off the job injuries: similarities and differences in circumstances

G S Smith, G S Sorock, H M Wellman, T K Courtney and G S Pransky

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ORIGINAL ARTICLE

Blurring the distinctions between on and off the job injuries: similarities and differences in circumstances

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Objectives: To compare the causes of non-fatal work and non-work injuries and the places or environments where they occur. It has been suggested that many injuries may have similar etiologies on and off the job and thus involve some common prevention strategies. However lack of comparable data on work relatedness has prevented testing this proposition.

Methods: The National Health Interview Survey (NHIS) now collects information on the cause, location, and work relatedness of all medically attended injuries. National US estimates of non-fatal work and non-work injuries were compared by cause and place/location for working age adults (18-64 years).

Results: Overall 28.6% of injuries to working age adults were work related (37.5% among employed people). The causes and locations of many work and non-work injuries were similar. Falls, overexertion, and struck/caught by were leading causes for work and non-work injuries. Motor vehicle injuries were less likely to be work related (3.4% at work v 19.5% non-work) and overexertion injuries more likely to be work related (27.1% v 13.8%). Assaults were less than 1% of work injuries and 1.8% of non-work injuries. Both work and non-work injuries occurred in every location examined—including the home where 3.5% of injuries were work related.

Conclusions: Work and non-work injuries share many similarities suggesting opportunities to broaden injury prevention programs commonly restricted to one setting or the other. Comprehensive efforts to prevent both non-work and work injuries may result in considerable cost savings not only to society but also directly to employers, who incur much of the associated costs.

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Injuries both on and off the job represent a significant burden not only to society but also to the workplace.^{1,2} Earlier we suggested that many work and non-work injuries may have similar etiologies regardless of where they occur, and may involve common prevention strategies,^{3,4} but the lack of comparable data on both types of injuries limited the ability to evaluate this proposition.

Most population based injury data systems cannot distinguish between work and non-work injuries.¹ Separate workplace based surveillance was developed for occupational injuries but most focus on traditional employment relationships and suffer from considerable underreporting.^{1,5-9} Some emergency department (ED) databases now identify work related injuries but rely on recorded work relatedness in the medical record, and exclude injuries treated elsewhere.^{10,11} The revised US National Health Interview Survey (NHIS) provides much-improved population based data on non-fatal injury causes and assesses the work relatedness of all medically treated injuries regardless of where they are treated.^{1,12} Earlier work reported that occupational injuries comprised almost 30% of all injuries to working age adults (18-64 years).¹ This present study extends our exploration of the NHIS to examine the extent to which work and non-work injuries have similar causes and injury locations, and thus may share common prevention strategies.

METHODS

Source of data

The National Health Interview Survey (NHIS) collects data on the health of a nationally representative sample of civilian non-institutionalized US residents.^{13,14} Beginning in 1997, a redesigned survey added much more information on injuries.¹² We examined the first three years of the redesigned survey (1997-99); subsequent years were not included as changes in questionnaire wording and design raised concerns over

comparability of injury estimates.¹ Analyses were restricted to cases 18-64 years of age (working age population).

A face to face laptop Computer Assisted Personal Interview (CAPI) was conducted with an adult member (18 years or older) of selected sample households. This person provided demographic information and employment status on all family members residing in the household as part of the Family Core (fig 1).^{12,14} We did not use the Sample Child or Sample Adult files as they contained no additional injury information. The basic structure of the survey and the unweighted number of respondents are shown in figure 1. Over the three year period 113 614 households provided information on 298 388 household members. The overall response rates for the surveys in 1997, 1998, and 1999 were 90.3%, 88.2%, and 86.1% respectively.^{14,15}

Injury information in NHIS

The injury questions were developed with input from injury prevention researchers and NCHS staff.¹² The adult respondent for the household reported on episodes of medically attended injury (work and non-work) for all members of the household, in response to:

"DURING THE PAST THREE MONTHS, that is since {91 days before today's date}, {were/was} {you/anyone in your family} injured seriously enough that {you/they} got medical advice or treatment?"

Verbatim text information on injury, body part, and how the injury happened is recorded in the field, and later used for coding at NCHS. Only injury descriptions codeable to the

Abbreviations: BLS, Bureau of Labor Statistics Surveys; CAPI, Computer Assisted Personal Interview; ICD-9CM, International Classification of Diseases, Clinical Modification; IRR, incidence rate ratio; NCHS, National Center for Health Statistics; NHDS, National Hospital Discharge Survey; NHIS, National Health Interview Survey.

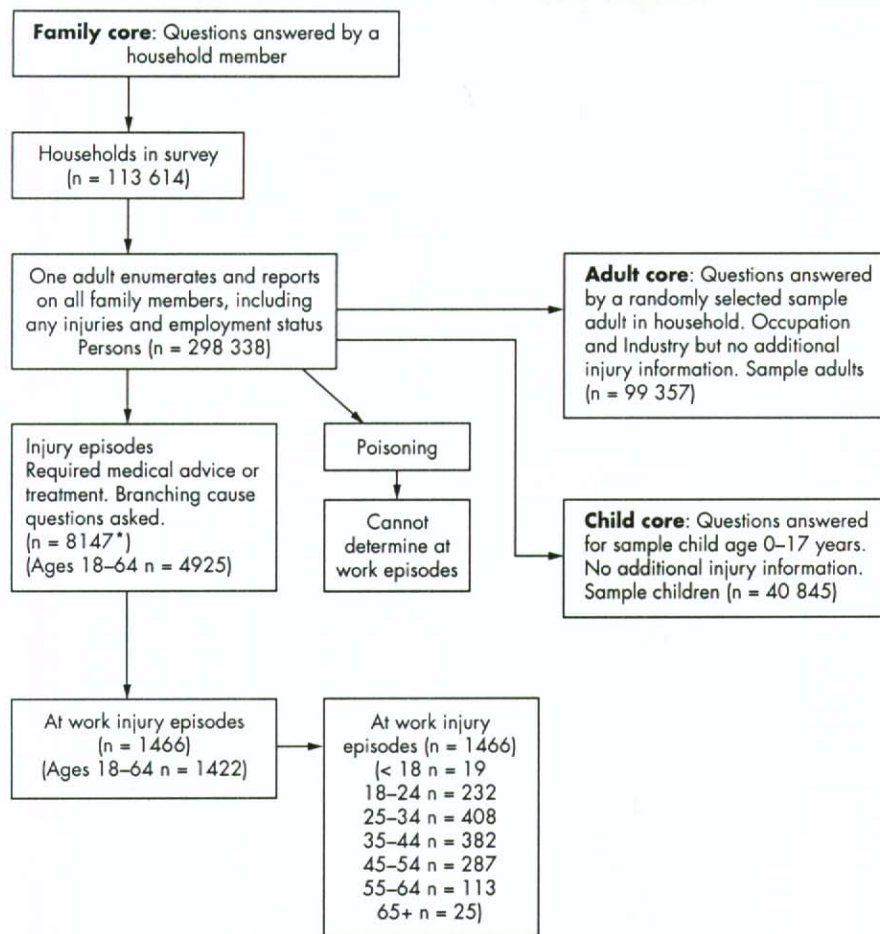


Figure 1 Injury and poisoning data on work injuries available from the National Health Interview Survey, 1997-99, US civilian population. *Twenty six military persons excluded.

International Classification of Diseases, Clinical Modification (ICD-9CM)¹⁶ nature of injury codes 800-999 are included in the injury file (includes acute musculoskeletal conditions but not gradual onset conditions such as tendonitis). Although separate poisoning questions were asked, we did not include these since work relatedness was not asked for poisonings in the years sampled (less than 0.6% of work related injuries based on ED data).¹ Study analyses are based on episodes of injury (n=4925); a single person may have multiple episodes.

Work relatedness

Work relatedness was determined from responses to: "What were you doing when the injury happened?" Up to two options were possible which captured multiple activities such as driving and working. If "working at a paid job" was selected for either option the injury was considered work related. After excluding injured respondents under 18 years (n=19) and over 64 years (n=25), 1422 work injury episodes were available for analysis in people of working age (34 people had more than one injury episode, two had three episodes).

Table 1 Characteristics of work related and all injury episodes, population (18-64 years old) by age and gender, NHIS 1997-99

	Annual rate per 100 people (95% CI)		Percent of injuries that were work related (95% CI)	
	All injury episodes*	Work related injury episodes†	Total population*	Employed population†
Total	11.7 (11.4-12.1)	4.5 (4.2-4.7)	37.5 (35.7-39.3)	28.6 (27.2-30.0)
Male	13.8 (13.2-14.4)	5.8 (5.4-6.2)	42.3 (40.0-44.6)	34.5 (32.5-36.5)
18-24	19.8 (18.2-21.6)	9.2 (7.7-10.7)	44.6 (39.0-50.1)	31.7 (27.6-35.8)
25-34	15.3 (14.0-16.6)	6.8 (5.9-7.7)	43.8 (39.5-48.1)	39.9 (36.0-43.8)
35-44	14.0 (12.9-15.1)	4.9 (4.3-5.5)	37.1 (33.0-41.1)	31.4 (28.1-34.7)
45-54	10.6 (9.4-11.8)	4.5 (3.7-5.3)	43.4 (37.8-49.0)	37.0 (32.3-41.7)
55-64	8.6 (7.5-9.7)	4.1 (3.2-5.0)	49.2 (39.6-58.7)	30.9 (24.4-37.4)
Female	9.8 (9.3-10.2)	2.9 (2.6-3.2)	29.7 (27.1-32.3)	20.5 (18.5-22.5)
18-24	10.1 (8.6-11.5)	3.7 (2.7-4.6)	34.0 (26.5-41.5)	22.4 (17.3-27.5)
25-34	9.9 (8.9-10.8)	2.8 (2.2-3.4)	29.4 (24.1-34.7)	20.6 (16.9-24.3)
35-44	9.6 (8.5-10.6)	2.6 (2.1-3.1)	27.5 (23.2-31.8)	20.6 (17.3-23.9)
45-54	10.2 (9.2-11.2)	3.2 (2.6-3.8)	31.5 (25.6-37.3)	22.9 (18.6-27.2)
55-64	9.0 (8.8-10.1)	2.5 (1.6-2.3)	26.2 (18.3-34.1)	13.7 (9.4-18.0)

*All people in the population age 18-64 regardless of employment (n=165 million).

†People who were reported to be employed at a job or business in the week before the interview (n=124 million).

Table 2 Number and percent distribution of work and non-work injury episodes, and percent of all injuries that are work related by external cause of injury, working age population (18–64 years), NHIS 1997–99

External cause of injury *	Work injury		Non-work injury		% Work related* (95% CI)
	Annual no (1000s)	%	Annual no (1000s)	%	
All falls (E800–E888)	1140	20.5	3877	28.0	22.7 (20.0–25.4)
Stairs/steps	118		801		
Ladder/scaffold	137		110		
From other height	236		428		
From same level	534		1823		
Unspecified	114		716		
Overexertion (E927)†	1533	27.1	1908	13.8	44.1 (40.6–47.6)
Overexertion: back or spine	659		745		
Overexertion: upper extremity	366		301		
Overexertion: lower extremity	295		711		
Overexertion: other	214		235		
Struck by/caught in (E916–E918)	923	16.6	1987	14.4	31.7 (28.0–35.4)
Struck by falling object	238		201		
Struck by/against obj or persons	490		1665		
Caught in/between objects	195		121		
Motor vehicle (E810–E825)	190	3.4	2694	19.5	6.6 (4.8–8.4)
Cutting/piercing (E920)	659	11.9	1132	8.2	36.8 (31.9–41.7)
Machinery (E919)	362	6.5	119	0.9	75.3 (67.3–83.3)
Other transport (E800–E807, E826–E848)	–‡	–	405	2.9	–
Animal-related injury (E906)	73	1.3	275	2.0	20.9 (12.3–29.5)
Hot/corrosive (E924)	160	2.9	179	1.3	47.1 (34.9–59.3)
Hot substances	89		151		
Corrosive material	70		28		
Assault/legal intervention (E960–E976)	–	0.9	245	1.8	16.9 (7.3–26.5)
Foreign body eye (E914)	177	3.2	105	0.8	62.7 (50.5–74.9)
Fire/flames (E890–E899)	–	–	47	0.3	–
Self-inflicted (E950–E959)	0	0.0	–	–	–
Medical injuries (E870–E879)	0	0.0	–	–	–
Other specified (all other E-codes)	58	1.0	118	0.9	32.8 (19.1–46.5)
Unspecified (E928.9)	164	3	641	4.6	20.4 (15.1–25.7)
Total	5546	100	13847	100	28.6 (27.2–30.0)

*Percent of all injuries, work and non-work combined, in group that are work related.

†Overexertion (E927) was stratified by body region to add detail.

‡Indicates estimates are unreliable, relative standard error of the estimate greater than 30%.

External cause of injury information

The CAPI collected up to 336 characters of text describing how the injury occurred and then asked a series of cause-specific prompts to probe for more detailed information on:

Vehicle as transportation (driver, passenger, etc, type vehicle, seatbelt/car-seat/helmet use), Fire/Burn/Scald (what caused it), Near drowning (body of water), Fall (What fell from or into, cause of fall such as slipping, jumping, loss balance), and Gun (type).

Cases assigned E-code 980–989 (undetermined intent, $n = 3$), E849 (place of injury, an invalid primary cause code, $n = 23$), and those with unknown causes (less than 1% of total) were reviewed and reassigned if possible to more specific E-codes. Overexertion injuries (that is, those occurring during activities involving lifting, pushing, excessive exercise or other strenuous body movements, E 927) were stratified by body region affected (back or spine, upper extremity, lower extremity, and other). Information on recodes is available from the authors.

Place of injury

Up to two responses were allowed to: "Where (were/was) [person] when the injury happened?" For 1998–99 the first reported place of injury was considered the main place of injury. However, because the order in which the place of injury was reported was not available in 1997, we manually selected the main place based on reviewing narrative text for 40 cases with multiple places.

Data analysis

National annual estimates of non-fatal work and non-work injuries for the US were made using sample weights provided

by the survey. Analyses were conducted using SAS version 8.0 (SAS Institute Inc, Cary, NC, USA) and SUDAAN to estimate standard errors and 95% confidence intervals accounting for the complex sample construction^{14, 17} as described elsewhere.¹ Injury distribution by cause and place were compared for work and non-work episodes and ordered by overall occurrence of work and non-work injuries combined. Rates are presented only for the leading injury causes because of wide confidence intervals for infrequent causes. Our Institutional Review Committee approved this study.

RESULTS

Of the estimated 19.4 million episodes of injury sustained annually by working age adults 5.5 million occurred "while working for pay". Work injuries comprised 28.6% (95% CI 27.2 to 30.0) of all injuries in the working-age population (18–64 years), and 37.5% (95% CI 35.7 to 39.3) in the employed population. Work and non-work injury rates and proportions varied widely by age and gender and were both highest in males 18–24 years (table 1). Rates by race/ethnicity, nature of injury, and body part were presented elsewhere.¹

Cause of injury

Falls, overexertion, and "struck by/caught in" were important causes of work and non-work injuries (table 2). The distribution of causes between work and non-work injuries were comparable for most cause groups, except for motor vehicles (3.4% of work injuries compared to 19.5% for non-work) and machinery injuries (6.5% of work injuries and 0.9% for non-work). Work related machinery injuries and foreign bodies in eyes comprised over 50% of all injuries from these causes while motor vehicle related injuries, falls, other

Table 3 Place of injury for work and non-work injury episodes, working age population (18–64 years), NHIS 1997–99

Place of injury	Work injury		Non-work injury		% of injuries*
	Annual no (1000s)	%	Annual no (1000s)	%	Work related (95% CI)
Home	239	4.3	6528	47.1	3.5 (2.5–4.5)
Street/highway	310	5.6	2803	20.2	9.9 (7.5–12.3)
Park/recreation/outdoor area	100	1.8	2200	15.9	4.4 (2.4–6.4)
Industrial/construction/mine	1879	33.9	50	0.4	97.4 (96.0–98.8)
Trade and service area	1125	20.3	350	2.5	76.3 (71.6–81.0)
Other public building	421	7.6	218	1.6	65.9 (59.0–72.8)
Health care/residential institution	376	6.8	144	1.0	72.3 (62.7–81.9)
Parking lot	179	3.2	275	2.0	39.5 (30.3–48.7)
School/child care center	137	2.5	312	2.2	30.5 (21.9–39.1)
Farm	56	1.0	115	0.8	32.5 (18.4–46.6)
Other	680	12.3	517	3.7	56.8 (50.9–62.7)
Unknown	†	0.8	335	2.4	–
Total	5546	100	13847	100	28.6 (27.2–30.0)

*Percent of all injuries, work and non-work combined, in group that are work related.

†Indicates estimates are unreliable, relative standard error of the estimate greater than 30%.

transport, and animal injuries were less likely to be occupationally related. Overexertion injuries (mainly sprains and strains) to the back or spine comprised about 40% of both work and non-work overexertion injuries. Work injuries were more likely to involve the upper extremity whereas non-work injuries more often involved the lower extremity. Specific types of falls varied between work and non-work, with falls from ladders being 12% of the falls at work while constituting only 3% of non-work falls; falls from stairs were less than 10% of falls at work but 20% of non-work falls.

Falls had the highest rate for all injuries (3.0 episodes/100 people) followed by overexertion (2.1/100), struck by/falling against object or person (1.8/100), motor vehicle injuries (1.7/100), and cutting and piercing injuries (1.1/100) (data not shown). For work injuries the highest rates were for overexertion (1.2/100 employed population), falls (0.9/100), struck by/falling against object or person (0.7/100), cutting and piercing (0.3/100), and motor vehicle injuries (0.2/100). Comparison of incidence rate ratios (IRR = non-work injury rate for total population/work injury rate for employed population) revealed that non-work injury rates were much higher for motor vehicle (IRR = 10.7) and other transport injuries (IRR = 10.5), and much lower than work injury rates for machinery injuries (IRR = 0.2), foreign bodies in eyes (IRR = 0.4), hot or corrosive materials (IRR = 0.8), and similar for overexertion injuries (IRR = 1.0).

Place of injury

The place of injury occurrence varied in ranking for work and non-work injuries, but both work and non-work injuries occurred in every location examined (table 3). The most common places for work injuries were industrial/construction areas (including mines) followed by trade and service areas; together these comprised 54% of work injuries; an additional 10% occurring in other traditional workplaces such as healthcare institutions, schools, or farms. Non-work injuries were more likely to have occurred around the home, followed by street/highway and park/recreation/outdoor areas. Although only 10% of injuries occurring on the street or highway were work related, 40% of those occurring in parking lots were work injuries. Although most injuries occurring in a private home were not work related, 3.5% of them were, comprising 4.3% of all work injuries.

DISCUSSION

The similarities in characteristics between non-fatal work and non-work injuries support the premise that injuries often share similar characteristics regardless of where they occur.^{2 3}

While certain injuries are unique to the workplace, many causes were similar to non-work injuries. Falls were the first or second leading cause of work and non-work injuries and three of the top four causes were the same. Certain causes such as transport injuries were less likely to occur while working, while machinery related injuries and foreign bodies in eyes were more likely. Only three of the 16 cause categories had higher rates at work than for non-work injuries (overexertion, machinery related, and foreign bodies in eyes).

Although there are clearly marked differences in the place of injury occurrence between some work and non-work injuries, many work injuries occur in similar places to non-work injuries. Place is not a good indicator of work relatedness as 3.5% of home injuries, 9.9% of street/highway injuries, and 66% of injuries in public buildings occurred while working. About a third of our work injuries occurred in non-traditional workplaces where occupational exposures are often not considered, and where prevention strategies for work and non-work injuries are often similar. Sample size limitations prevented examining differences in reporting work relatedness by workplace.

Many studies have examined all injuries, work injuries, or specific types of injuries, but studies comparing causes of work and non-work injuries have been limited.^{1 10 11 15 18 19} NHIS formerly collected limited data on injury causes and generally only considered broad classes of injury based on combinations of place and activity which were not mutually exclusive (that is, home, motor vehicle, work, and other place).¹² The much improved data on injury circumstances now in NHIS enabled us to determine the causes and circumstances of both work and non-work injuries.

A major strength of the NHIS for occupational injury surveillance is that it is population based and provides data on all medically treated injuries among people injured at work, regardless of workers' compensation coverage, industry or employment status, or the severity of injury. It also asks work relatedness directly of the injured person or their proxy. Most health data sources do not report work relatedness.^{1 3 20} Occupational injury data sources rely on recording work relatedness in medical records or by third parties (for example, employers), and may only examine one level of medical care such as emergency departments, excluding many injuries treated elsewhere.^{1 10 11} Our earlier study found that 22% of work injury episodes occurred to industry groups excluded by Bureau of Labor Statistics Surveys (BLS) (for example, self-employed people, government workers, and most workers on farms and in the informal workforce). For injuries resulting in one or more days away from work, our estimates for private

industry were 1.4 times comparable counts from BLS, confirming underreporting even for covered industries.¹

There are however conceptual difficulties in determining definitions for occupational injuries.^{4 21 22} For some injury events such as an assault in a bar, one person may be working and others not. In NHIS respondents have to consider themselves as "working for a paid job" in response to the question "What were you doing when the injury happened?" Thus some workers, such as volunteer firefighters or those working in a family business or farm, may not report their injuries as work related, even though they meet national criteria for work relatedness.²²

Despite findings that many injuries have similar etiologies regardless of where they occur, occupational injuries are often considered to be a separate entity from other injuries and there is often limited interaction between these two fields of injury prevention.²⁻⁴ Different agencies are involved in the monitoring and prevention of work and non-work injuries which may be a barrier to optimizing resources for designing and implementing some effective prevention programs. Many workplaces are not covered by traditional occupational health and safety protection services and the nature of work is also changing with an increasing number of self-employed, contractual, and home based workers, including telecommuters.^{2 9 23} Injury-producing tasks done in the home could be related to home based businesses, non-work activities, or be done by others for pay. Certain tasks in the home, such as car maintenance and working on roofs, may in fact be more safely done by professionals, especially for the elderly.²⁴ We found 3.5% of injuries occurring in homes were work related, but cannot distinguish whose home it was.

Although the relative importance of different causes may vary between work and non-work injuries, the solutions for preventing them may often be similar.² Falls for example were an important cause of work and non-work injuries and many risks may be similar. Improvements in the environment or product designs may reduce the risk of falling at work and home. Many other prevention strategies may be applicable both in the workplace and in the community, such as efforts to reduce substance abuse and subsequent alcohol related injuries, reducing the weight of objects and packages to prevent back injuries, prevention of bystander and commuting injuries, and workplace programs to increase seatbelt use.^{2-4 21 25} However few studies have examined similarities between on and off the job injury prevention strategies. More work is needed to determine which injuries share similar characteristics and which do not.

For many injuries a community based approach to prevention may be needed.^{2-4 26} Successful examples are the initiatives to prevent occupational injuries to teens,²⁷ and farm and migrant workers.²⁸ The workplace may also represent an opportunity to both implement and evaluate community prevention efforts. Workplace based health promotion is effective at improving safe lifestyles, such as workplace based smoking cessation and restrictions which reduce both on and off the job smoking.²⁹ Similarly the workplace may also represent an opportunity to evaluate in a controlled environment whether effective workplace based strategies, such as seat belt use promotion,²⁵ can also prevent injuries occurring off the job. Programs to prevent injuries in the community may also result in direct savings to employers, who are becoming increasingly concerned about the escalating medical and other costs resulting from off the job injuries, much of which is paid for by workplace based health insurance in the US.^{30 31}

The new injury questions in the NHIS represent a major improvement in injury cause information, especially the addition of narrative text. This text not only provides data to support injury cause coding, but also allows recoding of

injuries such as in sports and recreation^{15 18} and to explore computerized coding of narrative text.³² Text fields also provide valuable data for use in developing prevention strategies.³³ A unique feature of NHIS is the use of specific interactive prompts that collect more detailed information on specific causes. These prompts increase the specificity of cause coding, overcome some limitations of free text fields (especially inconsistencies in recording information), and were made possible because of computerized data entry in the field. The narrative description also allowed us to correct the coding of injuries we believed were miscoded. In our analyses only 4% of the injuries had non-specific causes while 11% had insufficient information to code the nature of injury.

Work injuries could be overreported if they were more likely to be medically treated. While we could not examine this it is also possible that the work relatedness of some reported injuries was not identified because work relatedness was only asked as part of a general activity question with up to two responses allowed, instead of asking a separate work injury question as has been recommended.¹ Very few episodes had more than one activity listed, which may have resulted in underrepresentation of work relatedness, especially for motor vehicle injuries. The lower proportion of motor vehicles in work versus non-work injuries, however, likely reflects exposure differences, particularly as commuting to and from work is not considered work related in the US. The incidence of self-inflicted and assault related injuries (work and non-work) was much lower than for unintentional injuries. This may reflect that many intentional injuries are more serious with higher case fatality rates, and thus are more represented in injury fatality and hospitalization data.³⁴ However intentional injuries may also be underreported in surveys. The Cognitive Questionnaire Lab at NCHS found that "the setting of interview was not conducive to identifying assaults and intentionally self-inflicted injuries".¹²

Recall bias can also affect injury reporting. Recent NHIS analyses found that restricting injuries to one month (five week) recall periods increased the total annual estimates by 5% over using three months. However there was no significant reduction for more severe injuries.³⁵ While increasing the recall period from two weeks to three months in the 1997 NHIS redesign may decrease somewhat the annual estimates of injuries reported, the greatly increased number of injury episodes available make comparative analyses such as ours possible. Increasing injury severity from at least a half day of restricted activity and/or medical assistance to only those seeking medical advice/treatment also improves reporting as more severe injuries are better recalled.³⁵⁻³⁸ Our injury rates may also be underestimated because only one person reports injuries for the household. Proxy respondents were difficult to identify in the versions of NHIS we used and further examination of this issue was beyond the scope of this paper. Other studies have shown that proxies tend to report health information less reliably than self-reports³⁹ but the limited studies for injuries suggest that it has a small effect on reported injuries.^{40 41}

CONCLUSION

The new revised NHIS provides an important new source of data on injury causes, and work relatedness. Our study demonstrates that injuries on the job are an important part of the total US injury burden and share many characteristics with injuries occurring in the community. The blurring of the distinctions between on and off the job injuries offers an opportunity to broaden injury prevention programs that are now commonly restricted to one setting or the other. Reducing non-work and work injuries to working age adults may result in considerable cost savings not only to society but also in the workplace.

Key points

- Comparable data on injury causes and location have not been available for work and non-work injuries.
- Overall 28.6% of injuries to working age adults were work related (37.5% among employed people) based on analysis of improved injury information available in the US National Health Interview Survey.
- Falls, overexertion, and struck/caught by were leading causes for work and non-work injuries while motor vehicle injuries were less likely to be work related (3% at work v 15% overall) and overexertion injuries more likely (27% v 18%).
- Both work and non-work injuries occurred in every location examined, including the home where 3.5% of injuries were work related.
- Work and non-work injuries share many similarities suggesting opportunities to broaden injury prevention programs commonly restricted to one setting or the other.

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The Liberty Mutual Research Institute for Safety Institutional Review Committee approved this study.

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