ORIGINAL ARTICLE

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, G S Pransky

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See end of article for authors' affiliations

Correspondence to: Dr G Smith, Liberty Mutual Research Institute for Safety, 71 Frankland Road, Hopkinton, MA 01748, USA; Gordon.Smith@LibertyMutual.com

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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.

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.

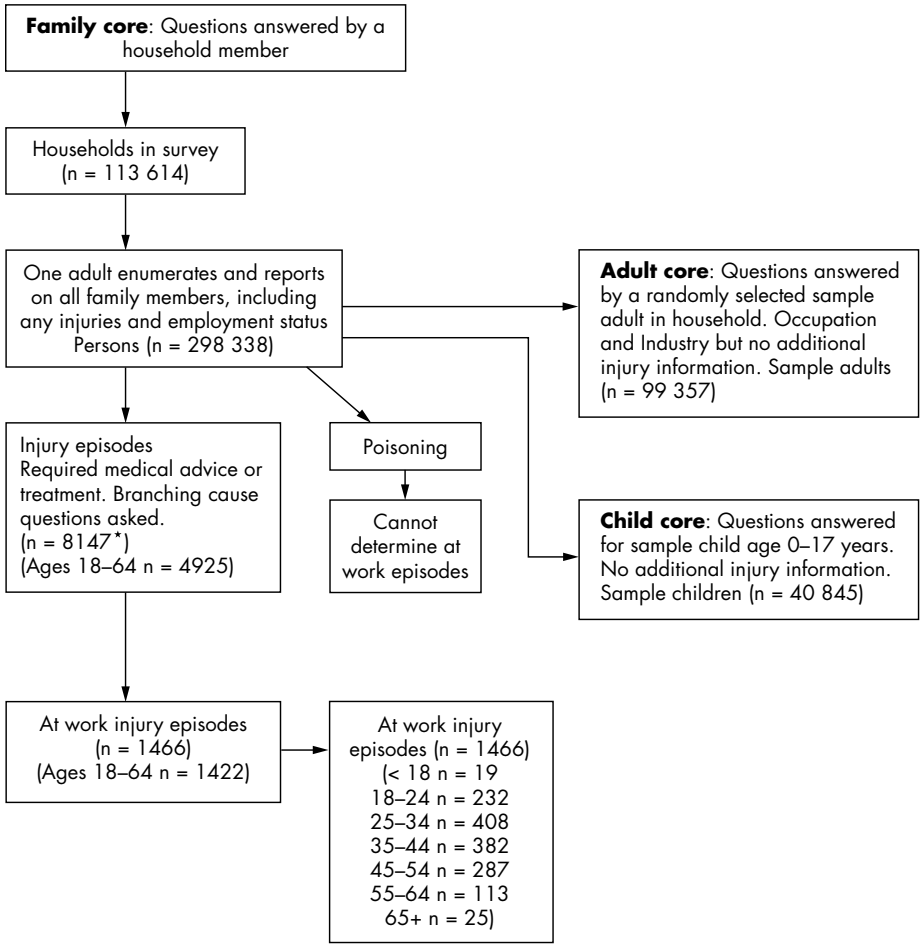

Figure 1 Injury and poisoning data on work injuries available from the National Health Interview Survey, 1997–99, US civilian population. *Twenty six military persons excluded.

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

	Work injury		Non-work injury		
External cause of injury	Annual no (1000s)	%	Annual no (1000s)	%	% Work related* (95% CI)
All falls (E800–888)	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

	Work injury		Non-work injury		% of injuries*
	Annual no (1000s)	%	Annual no (1000s)	%	Work related (95% CI)
Place of injury					
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 injures, 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 fire-fighters 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-reports[39] 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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Authors' affiliations

G S Smith, H M Wellman, T K Courtney, G S Pransky, Liberty Mutual Research Institute for Safety, Hopkinton, MA, USA
G S Sorock, Johns Hopkins Bloomberg School of Public Health, Baltimore, MD, USA

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