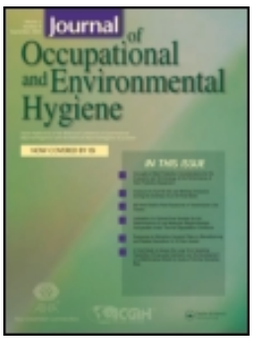

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A Case-Crossover Study of Transient Risk Factors for Occupational Hand Trauma by Gender

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An estimated 8.2 million occupational injuries occur annually to women in the United States. This case-crossover study of 1166 subjects compares transient risk factors for occupational traumatic hand injury to women and men. Study subjects were recruited over a 3-year period (1997 to 2000) from 23 occupational health clinics in five New England states. The case-crossover design was used to estimate the short-term risk of an acute hand injury while controlling between-person potential confounders. Subjects reported on the occurrence of seven transient exposures within a 90-min period and provided control exposure information during the month before an acute hand injury. A total of 275 women and 891 men were interviewed a median of 1.3 days after injury. Lacerations were the most common injury type in both women (58%) and men (64%). Relative risks for women were higher for being distracted, doing unusual tasks, and working with malfunctioning equipment or materials, and were lower than men for being rushed. Gloves provided significant protection for males and females. Results suggest the importance of considering both the prevalence of various exposures and gender in modifying risk factors to reduce the incidence of acute hand injury in the workplace. Thus, greater emphasis should be placed on the planning of safer working environments for all workers.

Keywords case-crossover, gender, hand, risk factors, transient, traumatic injury

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INTRODUCTION

An estimated 19.4 million nonfatal injury episodes occurred to adults aged 18–64 annually in the United States during the period 1997–1999. Of these injury episodes, 8.2 million occurred to women and 1.7 million (21%) were work related.[1] Although overall annual injury rates are 40% higher for men than women (13.8 vs. 9.8 per 100 persons), the work-related injury rate for men was twice the rate for women (5.8 vs. 2.9 per 100 persons). Males generally are reported to have higher on-the-job injury risk than women;[2] however, regardless of gender, the national injury burden is immense at work and at home.

Many occupational injury studies fail to stratify by gender in reporting their results, and consequently in some cases, controlling for gender may lead to biased results when gender is a marker of work conditions. Injuries to women at work have not received as much attention as injuries to men, and further development of strategies to prevent unintentional nonfatal injury to women is needed.[3]

As demographic changes in the U.S. work force continue to occur, it is likely that the distribution of occupational injuries also change. For example, it is estimated that from the period 2002–2012, the number of women in the labor force will increase by 14.3% (vs. 10% for men),[4] and women will comprise 47.5% of the entire U.S. labor force by the end of this period.[5] From 1996 to 2005, women have been moving into jobs with higher injury risk and this is projected to continue. For example, women are moving into higher-risk jobs such as truck driver or construction work, and out of lower-risk jobs such as cashier and other service-based jobs.[6] Currently, the leading work-related nonfatal injuries in women are from falls, overexertion due to lifting, and collisions between vehicles.[6]

BACKGROUND

Few studies have examined risk factors for nonfatal injuries to women in the workplace, and among those the findings

are somewhat conflicting. A matched case-control study of 156 injured female manufacturing workers reported that the majority of injuries were to the upper extremity (79%), and most were sprains, lacerations, and bruises.[7] Significant risk factors for these injuries were injury history and having children under the age of six. However, these two risk factors were significant only for minor injuries or those with no lost work time.

When some studies have attempted to compare injury rates between men and women in comparable job situations, results show that women have higher injury rates than men. However, studies examining gender differences in occupational injury risk have done so with varying degree of control for job classification. In a cohort study of postal workers, occupational injury risk was higher for female than male letter carriers and letter-sorting machine clerks; however, this excess risk was present in the first year of employment only.

Conversely, among mail handlers, the relative risk of injury was higher for females only after the first year of employment.[8] Similarly, a study of injuries in the semiconductor-manufacturing industry reported that women had a 37% higher incidence of occupational injuries than men on comparable jobs.[9] Interestingly, women in an electric utility company had higher rates of injury in non-office occupations than their male counterparts.[10] In contrast, for work-related eye injuries, men had higher injury rates than women in military occupations, even after adjustment for specific occupational specialty.[11]

Other studies examining injury risk have found no significant difference between men and women when controlling for job classification using Bureau of Labor Statistics data.[12] When job classification can be matched very closely by a single physical task (e.g., data entry keying), the risk of carpal tunnel syndrome injuries was similar between men and women.[13] Women and men may have similar injury risks when the job task and work practices are closely matched, which is often difficult to achieve in an observational study.

Cuts and lacerations of the fingers ranked third after back and leg strains in the number of lost workday cases in the United States in 1994. The incidence rate of hand injuries studied in seven manufacturing environments around the world ranged from 4 to 11 per 100 workers per year, workers aged 24 years or less had the highest risk of hand injury.[14] Men had higher rates of severe hand injury than women. Despite the high frequency and significant amount of lost work time associated with these injuries, from an etiological perspective, they are still poorly understood.

There is only one case-control study of occupational hand injury in the literature[15] that suggests an important role for both stable (age) and transient risk factors (doing an unusual task) at the time of the injury. More analytic epidemiological research is needed to identify potentially modifiable risk or protective factors (e.g., glove use) for acute hand injuries to both men and women.[15]

The case-crossover design has been used to identify transient risk factors for sudden onset events, while controlling for between-subject factors such as industry, occupation, age, gender, injury history, or other factors that are stable over time.[16–18] This design uses self-matching to control for potential confounding by differences between individuals that remain stable within an individual over relatively short time periods, such as age, gender, occupation, and job experience.

However, these stable factors can be evaluated as effect modifiers of transient exposures (e.g., rushing, distraction, or doing an unusual work task) on injury risk. In this article, we present analyses of acute traumatic hand injuries, separately for men and women, including descriptive and case-crossover analyses of risk factors.

METHODS

Subject Recruitment

Subjects were recruited over a 3-year period (1997 to 2000) from 23 occupational health clinics in five New England states: Massachusetts, Connecticut, Rhode Island, Vermont, and Maine. Further details of the study methods are provided in earlier publications.[17,19,20]

To be eligible for the study, subjects must have had one or more of the following types of injury to the fingers, hand, or wrist while at work: laceration, crush, avulsion (tearing away part of the skin), puncture, fracture, contusion, amputation, or dislocation. After subjects were asked to give their written informed consent for a telephone interview, a clinician verified the date, time, and type of injuries and completed a case information form. Both forms were faxed to the data-coordinating center and given to interviewers who conducted the telephone interviews in the evening or outside the work or clinic environment.

Of 1522 subjects eligible for an interview, 1179 (77.5%) completed the interview using a structured questionnaire. Thirteen subjects were excluded from further analysis due to poor quality of responses or not meeting the case definition. Therefore, 1166 subjects were evaluated in the study. To improve statistical power, women were oversampled in this study by limiting subject recruitment to only women in the last 10 months of data collection.

Study Design

The case-crossover design was used to estimate the relative risk of an acute hand injury for seven potential risk factors. Using injured workers as their own controls, each subject was asked about transient exposures, such as rushing, at the time of the injury and in the previous work-month as the control period. The within-person study design controls for potential differences between individuals that are stable or stable over time such as age, handedness, occupation, job experience, and safety training.

Exposure at the Time of the Injury

Questions were asked about exposures to seven specific transient factors during the 90-min time period before the injury and the answers were recorded on a work-time-before-

injury log by the interviewer. The seven transient factors studied were: using a machine, tool, or work material that performed differently than usual; wearing gloves; performing an unusual task; doing a task using an unusual work method; being distracted or rushed; and feeling ill. Unusual performing equipment/materials included a jammed machine, malfunctioning hand tool, a recently sharpened knife, or a work piece that was easier or harder to cut than usual.

If the subject responded positively to being exposed to any transient factor, she or he was asked when the exposure occurred during the 90 min of work-time. Subjects who reported an exposure *simultaneous* with the time of the injury were considered exposed in the analysis. In addition, those subjects who reported being rushed or distracted at the time of the injury were asked to describe why they were rushing or distracted.

Exposure in the Control Period

Each subject was asked to estimate their average frequency and duration of exposure to each of seven transient factors in the past work-month. Next, the average frequency was multiplied by the average duration of exposure to estimate the number of exposed hours per month of work time. For example, if a subject reported rushing three times a week, for 2 hr on average, given 4.3 weeks in a month, the total estimated time exposed to rushing per month for this subject would be $3 \times 2 \times 4.3$ or 25.8 hr per month. For each transient exposure, unexposed work time was determined by subtracting the amount of exposed work time in a month from the total amount of time that each subject reported working including overtime. The test-retest reliability of the questionnaire was evaluated in 29 subjects who were re-interviewed up to 4 days after the initial interview and asked again about the estimated number of hours of exposure during the past month.[21] The reliability of recalled number of hours of exposure in the past month was high for six of seven transient risk factors (intra-class correlation coefficients [ICC] ranging from 0.84–0.99); reliability was lower for being distracted (ICC = 0.55).

Data Analysis

In the case-crossover design, the individual subject is the stratifying variable. We estimated the relative risk and 95% confidence intervals for these highly stratified data using the Mantel-Haenszel estimator for person-time data.[22] Relative risk estimates are based on the ratio of the observed frequency of exposure to each transient factor at the time of the injury to the expected frequency of exposure in the past work-month. The past work-month before the injury is the control-time period selected for this analysis. The average incidence rate ratio (relative risk) refers to the rate of having a sudden-onset hand injury when exposed to each potential transient risk factor compared with the rate when unexposed.

Because the time interval under study is very short, the incidence rate ratio can be interpreted as the short-term risk of a sudden-onset hand injury. Chi-square tests of homogeneity were used to evaluate changes in the relative risk estimates across gender.[22] Gender is stratified as an effect modifier in the individual analyses. Thus, the analytic approach controls for differences between gender and task demands that can vary by gender even in the same job classification.[23]

RESULTS

Study subjects were interviewed a median of 1.3 days after seeking treatment for their hand injury. Women (n = 275) were 38.7 years old ± 0.7 (standard error of the mean) and were 2 years older than men (36.7) (n = 891) (Table I). The majority of women were white (75%), 13% were Hispanic, and 8% were Black/non-Hispanic. Compared with men, women had 3.7 fewer years of experience on the task they were doing when injured. Women also had, on average, 1.2 fewer years of job experience than men.

TABLE I. Characteristics of Patients with Acute Hand Injuries Presenting to Occupational Health Clinics in New England (1997–2000)

Characteristic	Male (N = 891)		Female (N = 275)	
Age (Years)				
Mean (SEM)[A]	36.7 (0.4)		38.7 (0.7)	
Race/Ethnicity	n	%	n	%
White/non-Hispanic	537	78.1	184	75.1
Hispanic	81	11.8	32	13.1
Black/non-Hispanic	39	5.7	20	8.2
Other	31	3.4	9	3.2
Occupational Category	n	%	n	%
Machine trades	323	36.3	60	21.8
Construction	163	18.3	9	3.3
Service	101	11.3	73	26.5
Assembly	68	7.6	35	12.7
Clerical/sales	49	5.5	21	7.6
Prof., tech, managerial	48	5.4	37	13.5
Miscellaneous	139	15.6	40	14.5
Task Experience (months)				
Mean (SEM)	121.1 (4.5)		76.7 (5.8)	
Hours Worked Past Month[B]				
Mean (SEM)[A]	196.6 (1.1)		179.2 (2.3)	
Safety Training on Task	n	%	n	%
Yes	294	43.0	93	38.1
Union Member	n	%	n	%
Yes	106	25.9	26	14.6
Safety Officer on Site	n	%	n	%
Yes	432	62.7	131	53.5

Notes: Age was missing for 7 males and 4 females; race/ethnicity was collected only during the last 2 years of the study; task experience based on 688 males and 233 females; hours worked was missing for 12 males, 0 females.

[A] SEM = standard error of mean.

[B] Includes overtime.

The mean and standard error of job experience in months for women and men, respectively, were 66.8 ± 5.2 and 81.6 ± 3.2. Fewer women than men were union members, and fewer women knew if there was a safety officer on site. These differences are likely to reflect, in part, different employer sizes and occupational differences between men and women. In decreasing order, women worked in service, machine trades, professional technical and managerial trades, assembly work, and miscellaneous work. Men worked in machine trades, construction, service, packaging and material handling, assembly work, sales, and professional technical and managerial trades.

A higher proportion of women than men were cut or struck by a nonpowered tool with a blade or by a powered machine (Table II). The distribution of injury source and nature of injury may be a reflection of the larger numbers of women than men in the food service industry where cutting equipment (e.g., deli slicing machines) and knives are commonly used.

Twelve percent of women were left-handed, as were 11% of the men. Of the 301 hand injuries sustained by the 275 women, 57.6% were lacerations, 14.9% crushes, 10.2% avulsions, 6.8% punctures, 6.2% contusions, 3.7% fractures, and 0.6% amputations, and 2% other injuries (Table II). Most women (85%) had a single injury type, 13% had two injuries and 2% had three injuries. Because most women were right handed, the left hand, or nondominant hand, was struck more often than the right (57% vs. 43%). The index finger, thumb, and palm of the left hand were struck most often. The dorsal side of the index finger of the left hand was involved in most (9.4%) of the injuries. Women had fewer lacerations than men (57.6% vs. 64.1%) but more avulsion injuries (10.2% vs. 7.3%); however, women had fewer fracture injuries (3.7% vs. 5.1%) than men.

TABLE II. Hand Injury Characteristics

Characteristic	Male (N = 891)		Female (N = 275)	
Injury Source	n	%	n	%
Metal item	380	42.6	68	24.7
Nonpowered hand tool with blade	193	21.7	92	33.5
Powered machine	159	17.8	74	26.9
Nonmetal item	87	9.8	23	8.4
Other nonpowered hand tool	26	2.9	3	1.1
Not elsewhere classified	46	5.2	15	5.5
Nature of Injury	n	%	n	%
Laceration	691	64.1	186	57.6
Crush	135	12.5	48	14.9
Avulsion	79	7.3	33	10.2
Puncture	64	5.9	22	6.8
Fracture	55	5.1	12	3.7
Contusion	38	3.5	20	6.2
Amputation	14	1.3	2	0.6
Dislocation	2	0.2	0	0.0
Finger Location	n	%	n	%
Distal	439	55.2	161	65.4
Medial	219	27.5	58	23.6
Proximal	138	17.3	27	11.0
Laceration Length (cm)				
Mean (SEM)[A]	2.1 (0.05)		1.7 (0.08)	
Total Number Sutures				
Mean (SEM)[A]	4.6 (0.11)		3.9 (0.16)	

Note: Subjects may have more than one nature of injury code and more than one finger location of injury.
[A]SEM = standard error of mean.

Transient Risk Factors

Overall, 37% of subjects were unexposed to any factor at the time of the injury, 38% to one, 18% to two, and 7% to three or more. There was no statistically significant difference in the numbers of women and men exposed to 1, 2, 3, 4, 5, or 6 risk factors simultaneously (chi-square test of proportions, 5 df = 3.97, p = 0.55.)

A higher percentage of women were distracted at the time of the injury than were men. Fewer women were rushing than men, and fewer women than men were wearing gloves at the time of the injury (Figure 1).

Among subjects exposed in the past work month, most were exposed to glove use and rushing (Table III). Women had more hours on average of feeling ill per month (13.2 vs. 9.4 hr), and more hours for using a different method of doing a task (15.9 vs. 11.9). Men reported more hours per month of equipment or tool malfunction than women (19.4 vs. 15.0).

Taking into account individual work hours and exposure in both the control and case periods (exposure at the time of the injury), the relative risk (RR) for women of an acute hand injury varied from a high of 18.5 (95% confidence interval [CI] 11.9–27.0) for using equipment/materials that performed differently than usual to RR = 1.6 for feeling ill (95% CI 0.8, 3.0) (Table IV). Women had a significantly higher risk of a hand injury compared with men when doing an unusual task, being distracted, and using equipment/materials that performed differently than usual, but they had a lower risk associated with rushing. Glove use was significantly associated with a reduced risk of a hand injury for both women and men.

A higher percentage of women were distracted at the time of injury by speaking to co-workers or customers/bosses than were men (69% vs. 54%, respectively). Similar proportions of men and women reported being distracted by family or personal matters (11% vs.12%, respectively).

The effects of transient risk factors on injury risk were stratified by gender and tenure: less than 1 year, 1–3 years, and more than 3 years. For men and women, distraction was more likely to occur in the first year of employment than later, although the effect was strongest for distraction among women in the first year ($p \leq 0.01$, for homogeneity test). The rate ratios for women were 23.6, 5.1, and 7.1, and 8.6, 8.5, and 4.4 for men, respectively. No other transient risk factor for women was statistically significantly different by tenure. Men,

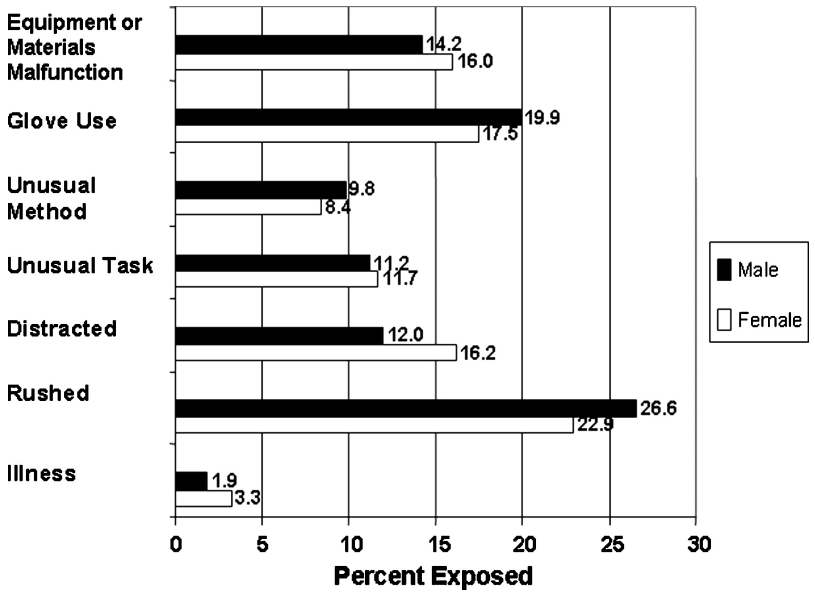

FIGURE 1. Prevalence of transient exposures at time of injury by gender. Percentage of subjects exposed to each of seven transient risk factors at the time of the injury by gender (males n = 891, females n = 275)

however, were more likely to do an unusual task early in their tenure than after 1–3 years; rate ratios were 8.7, 2.4, and 5.7, respectively.

DISCUSSION

These results emphasize the importance of various exposures that are associated with a significantly increased short-term risk (on the order of minutes or seconds) of an occupational acute hand injury. Although, the risk of hand injury at work does significantly differ by gender for some exposures (distraction, rushing, doing an unusual task, and using malfunctioning equipment/tools or materials) the direction of these effects for both genders were the same (increased). Explanations for these differences are only speculative at this point. In addition, to understand the impact of these transient risk factors on the absolute risk of workplace injury, one must consider the baseline risk of injury, the frequency of exposure

TABLE III. Working Hours Exposed to Potential Transient Risk Factors in the Month Prior to Injury

	Gender	Persons	Hours Mean	Std. Dev.	25%	Median (50%)	75%
Total Work Hours	Male	879	196.6	33.3	173	193.5	215.0
	Female	275	179.2	38.5	172	177.0	193.0
Exposure			Exposed Persons Only				
Unusual performing	Male	214	19.4	44.1	0.4	2.2	11.0
equipment/materials	Female	62	15.0	25.2	0.7	2.5	24.0
Different work method	Male	169	11.9	22.4	0.5	3.3	12.9
	Female	33	15.9	29.6	1.0	2.7	8.6
Doing an unusual task	Male	297	12.6	22.0	1.0	4.0	12.9
	Female	59	11.9	19.5	1.6	4.0	8.6
Being distracted	Male	438	11.4	30.1	0.3	1.4	7.2
	Female	120	11.8	31.3	0.4	1.1	5.6
Being rushed	Male	589	43.0	54.2	6.0	17.2	60.2
	Female	180	45.5	52.6	6.5	21.5	72.2
Feeling ill	Male	182	9.4	20.1	1.0	4.0	8.0
	Female	81	13.2	26.2	2.0	6.7	12.0
Wearing gloves	Male	611	78.9	68.2	10.8	60.0	139.8
	Female	160	78.5	65.5	10.8	71.0	129.0

TABLE IV. Relative Risk of an Acute Hand Injury

Exposure	Male		Female		Test for Homogeneity p-Value
	RR[A]	95% CI[B]	RR[A]	95% CI[B]	
Unusual performing equipment/materials	9.6	(8.1–11.4)	18.0	(11.9–27.0)	0.01
Different work method	10.5	(8.5–13.0)	10.4	(7.1–15.4)	0.96
Performing an unusual task	6.1	(5.0–7.4)	10.1	(7.0–14.6)	0.02
Distracted	4.5	(3.9–5.3)	9.3	(6.9–12.4)	≤ 0.001
Rushed	2.7	(2.3–3.1)	1.6	(1.3–2.1)	0.001
Feeling ill	2.1	(1.3–3.5)	1.6	(0.8–3.0)	0.48
Wearing gloves	0.4	(0.3–0.5)	0.3	(0.2–0.5)	0.31

[A] RR = relative risk.
[B] CI = confidence interval.

to the transient risk factor, and the relative risk associated with it.[17]

Use of equipment or machinery that is either malfunctioning, jammed, or stuck, or work materials (e.g., metal stock) that are malformed or have unusual sharp edges, have been associated with a high risk of hand injury. Machinery often has guards that protect the hand from reaching a pinch point but lets the work material through. The design recommendations for machine guards, however, were unchanged since the 1940s.[24] The guarded opening has a dimension that is designed for the male hand, not the female hand.

When comparing the anthropometrics of the hand among men and women (i.e., longest man's hand dimensions and the thinnest woman's hand) with machine guarding dimensions, some hazardous conditions arose based on machine guarding drawings. To protect the smallest women's hands at the middle finger joint, the maximum width of the machine opening has to be reduced from 13 mm to 11 mm. The elbow joint opening should also be decreased from 54 mm to 49 mm. The extent to which women were unprotected by current machine guarding precautions in this study is unknown. The finding that more women were being injured than men on the distal part of the finger may support this notion that women's hand dimensions may be too small to be adequately protected by machine guards (Table II); however, we are unable to explore this difference any further in this study because hand size was not measured.

Distraction was a significant risk factor for both women and men but was twofold higher for women than men. We did not ask subjects if they had a child at home under the age of six, which was previously found to increase the risk of injury in female aerospace manufacturing workers.[7]

Reasons for distractions among all subjects were due to talking or looking at a co-worker, thinking about nonwork tasks (perhaps family-related issues), or other external distracters. Distractions from co-workers or customers were greater for women than men, suggesting that work environments should try to reduce distractions for both women and men at high-risk times, such as when rushing or cleaning equipment

In addition, we have previously suggested that interactions between the organization of the workday and transient exposures (such as rushing and being distracted) are important in understanding the occurrence of injury in the workplace. For example, an injury may be more likely for a food service worker rushing in the early morning after an unusually long or short sleep, or for a manufacturing worker distracted while performing repairs to a jammed machine during the busiest period of the day. Temporal and transient factors may combine under different work conditions to synergistically "trigger" an injury.[25]

Doing an unusual task may be a reflection of the shorter job/task experience for women than men. Rushing, however, is associated with hand injury more so for men than women. These differences may reflect the different occupational exposures for men and women, that is, the baseline risk for hand injury may be greater in construction and manufacturing than retail and managerial occupations.

Performing an unusual task was associated with an equally high relative risk of hand injury for both genders; conversely, glove use was associated with a decreased relative risk (protective effect) of hand injury for men and women. Using an unusual tool for a task, putting the hand in a different location than usual, or using a different hand to do a task seems to be a short-term risk factor regardless of gender. Although grip strength is known to be greater in men than women, manual dexterity is not.[26]

Factors that influence why particular subjects would undertake a task differently are unknown. Glove use may reduce the risk of hand injury because of its barrier protection against energy transfer below a certain threshold. Gloves protect against lacerations and puncture but not against crush injuries,[19] regardless of gender. In food services, where many tasks involve cutting with knives, workers should have the option of wearing a cut-resistant glove on the nondominant hand to avoid lacerations. This might be a lightweight, washable Kevlar glove or a mesh glove similar to ones worn in the meatpacking industry.

A major strength of this study is control for stable characteristics that are different between individuals, such as age, experience, eye-hand coordination, reflex time, injury history, occupation, and safety training by a self-matched design.[17] However, in this within-subject design, both measured and unmeasured stable factors cannot be evaluated as risk factors for injury because they do not vary within an individual over a short time interval.

Although we are unable to examine these stable risk factors (e.g., occupation) that are also important determinants of workplace injury, these factors can be evaluated as effect modifiers. The current results cannot adequately address the basic issue of whether men and women in the same jobs have different risk factors associated with their work due to sample size and statistical power limitations within specific occupational categories.

However, a study by Smith et al.[11] examined whether occupation explains gender and other differences in work-related eye injury hospitalization rates. The authors reported that men had higher injury rates than women in military occupations, even after adjustment for specific occupational specialty.

One major limitation of retrospective research studies is recall bias. Subjects may have overestimated exposures close to the time of the injury. They may also have underestimated exposure in the control period because of memory lapse or difficulty in estimating exposure. This would bias the relative risks away from the null value.[16,17]

Furthermore, we implicitly assume that the nature of the job hazards has not changed significantly during the month prior to the injury. Unfortunately, there is no currently available gold standard for the self-reported, retrospective, transient exposures in this study. Although the reported transient exposures were reliable in a substudy,[21] this does not suggest they are completely accurate (or valid), rather, it suggests only that they were repeatable.

If the hazard period associated with a particular exposure is longer than that assessed, we may have underestimated the relative risk or failed to detect it. In this study, we hypothesized that the effect of the majority of the assessed exposures on the risk of hand injury would be immediate and, thus, designed our questionnaire to focus on a very short interval preceding the injury. However, for example, when feeling ill it is certainly plausible that the effect is more prolonged due to a direct effect of the illness or through an intermediate pathway resulting from the illness, such as lack of sleep or medication use. Thus, it is possible that our study provided a conservative estimate for this exposure.

Another limitation of this study is our inability to deconfound the effects of within-subject confounding by co-occurring transient risk factors. This is because we did not ask about the co-occurrence of transient risk factors in the control period (month prior to injury) and were unable to use the control period 1 hr before the injury due to the long median exposure duration of four of seven exposures. Even if we restricted the analysis to cases with just one exposure at the time of the injury, the control periods of those subjects could still have co-occurring exposures (e.g., being rushed and distracted) leading to some residual uncontrolled within-person confounding.[16,17]

Complex interactions may accumulate over time in relation to the acute onset of an injury that are difficult to distinguish within individuals. In the future, asking about exposures at the same time of the day on the previous workday or workdays, or by asking about rushing and other common transient exposures in the usual frequency period (1 month earlier) should be investigated. Other potential transient risk factors such as emotional upset or hangovers from alcohol intake are not examined in this study and may be important exposures to explore.

The differences in gender effects found in this study may be in part a reflection of the hazards associated with each job. However, all recognized hazards should be ameliorated regardless of the gender of the worker. Gender differences may help to suggest how gloves are to be designed to protect the hand, how machinery is to be guarded, and how the work environment and work is to be designed to protect all workers.

CONCLUSION

These results suggest that strategies to modify transient exposures (such as equipment or tools not performing as expected, using work methods that are different from usual to do a task or doing an unusual task, being rushed or being distracted) include behavior-based safety training and engineering or administrative controls to reduce the risk of a work-related traumatic hand injury.

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