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## Original Contribution

# Sex Differences in Injury Patterns Among Workers in Heavy Manufacturing

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The objective of the study was to determine if female workers in a heavy manufacturing environment have a higher risk of injury compared with males when performing the same job and to evaluate sex differences in type or severity of injury. By use of human resources and incident surveillance data for the hourly population at 6 US aluminum smelters, injuries that occurred from January 1, 1996, through December 21, 2005, were analyzed. Multivariate logistic regression, adjusted for job, tenure, and age category, was used to calculate odds ratios and 95% confidence intervals for female versus male injury risk for all injuries, recordable injuries, and lost work time injuries. The analysis was repeated for acute injuries and musculoskeletal disorder-related injuries separately. Female workers in this industry have a greater risk for sustaining all forms of injury after adjustment for age, tenure, and standardized job category (odds ratio = 1.365, 95% confidence interval: 1.290, 1.445). This excess risk for female workers persisted when injuries were dichotomized into acute injuries (odds ratio = 1.2) and musculoskeletal disorder-related injuries (odds ratio = 1.1). This study provides evidence of a sex disparity in occupational injury with female workers at higher risk compared with their male counterparts in a heavy manufacturing environment.

sex; women; wounds and injuries

Abbreviation: MSD, musculoskeletal disorder.

During the last 3 decades, the participation of women in the paid workforce has increased steadily and dramatically such that women presently comprise 46% of the paid labor force in the United States (1). In addition, women have been increasingly entering traditionally male-dominated jobs in construction, mining, heavy manufacturing, and agriculture though their representation in these sectors remains significantly less than that of men (2, 3). Data for 2006 from the US Department of Labor Bureau of Labor Statistics indicate that 2.7 million women are currently employed in the manufacturing of durable goods, such as primary and fabricated metal products, and machinery manufacturing and constitute 25.8% of that workforce (4). Although a large body of occupational safety and health research exists, until relatively recently most of this work focused on male workers. There is growing recognition in the literature that women are underserved by the existing research on occupational safety and health (5–7).

The (Bureau of Labor Statistics) Survey of Occupational Injuries and Illnesses provides aggregate estimates of workplace injury rates by standard industrial classification categories and serves as the primary source of occupational injury and illness data in the United States. On the basis of these data, in combination with data from other studies (8, 9), it was believed that women sustain fewer and less severe injuries at work than do men. However, it has become more widely recognized that interpreting male and female injury rates without taking into account the differential participation of women and men across occupations and industries may lead to inaccurate assessment of injury risk between the sexes because women and men often perform different jobs in the industrial categories examined (10). For example, in manufacturing industries, women are more frequently employed in relatively less physically demanding jobs, that is, administrative and clerical, where work is performed indoors and under more controlled environments;

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these administrative and clerical jobs are associated with fewer injuries.

Other studies have suggested that women employed in traditionally male-dominated jobs would suffer the same kinds of injuries with the same relative frequency as do their male counterparts (11–14). This implies that a combination of work activities, workplace culture, and work environment, rather than the worker attributes, is the more important determinant of injuries. Literature on the frequency and severity of work-related injuries in men and women who perform the same jobs remains unclear. Most of the studies appearing in the literature have used broad and heterogeneous occupational classifications that could potentially mask the differences in tasks done by men and women; others have restricted injuries studied to musculoskeletal disorders (15–20). Consequently, a need exists for further study of the complex relation between sex and occupational injury, which includes a wide spectrum of injuries at the job level.

The main objectives of this study were to determine if female aluminum smelter workers have a higher risk of occupational injury compared with their male counterparts when performing the same job and to evaluate if there are sex differences among the measures of injury sequelae in this population, namely, the type of injury and severity of injury.

## MATERIALS AND METHODS

The study population included all hourly production employees of a US aluminum production corporation at the company's 6 aluminum smelters in operation during the full study period from January 1, 1996, through December 31, 2005. These smelters were located in Tennessee, North Carolina, New York, Texas, Washington, and Indiana. The population and time contributed by each individual in person-years were determined from the company-maintained human resources database that included a complete job history, by job title, for each employee, as well as job category (hourly or salary), sex, date of birth, plant location, date of entry into the workforce, and, where applicable, date(s) of leave and date(s) of reentry. Injury events were obtained from the company's incident surveillance system, which was considered to be complete because all incidents, including minor ones that required only first aid, were required for reporting. A detailed description of this data system has been previously published (21–23). In the incident surveillance database, injury events are described by a nature of injury variable, which was used to dichotomize all injuries into either acute injuries or musculoskeletal disorder (MSD)-related categories for separate analyses. The acute injury category included all burns, contusions, lacerations, fractures, blisters, dislocations, eye injuries, abrasions, foreign bodies, punctures, bites and stings, and amputations. The MSD-related injuries included strains and sprains, pain in joint, nonspecific musculoskeletal pain, and hernias. In addition, events are classified by severity into 1 of 4 mutually exclusive categories of increasing severity: 1) injuries requiring only first aid without involving restricted work or lost work time; 2) injuries requiring medical treatment, defined as evaluation and treatment beyond first aid by a health-care professional without involving restricted work or lost work time; 3) injuries requiring work restrictions; and 4) injuries requiring lost work time. For injuries resulting in the restricted and lost work categories, the numbers of restricted work days and lost work days are captured in the database.

All injury events occurring between January 1, 1996, and December 31, 2005, in the 6 plants studied were included. An encrypted uniform unique identifier was created for each employee to ensure human subject privacy. A deterministic data set linkage strategy using this single identifier was used to link the human resources and incident surveillance databases for this study.

By use of the process previously described for this population (22), each human resources job title was assigned to a standardized job category. This allowed the collapsing of very similar jobs held by production employees across plants into standardized job categories for analysis. For the 6 smelters studied, the standardization process resulted in a total of 52 standardized job categories.

For determination of injury rates, numerator data included the number of sex-specific injury events. The denominator was the summed number of sex-specific person-years from the human resources database. In addition, to determine the effect of job on the relation between injury and sex, we summed the number of person-years and the number of injuries by sex for each standardized job category.

Descriptive statistics for the study population were calculated by sex. Population differences in age and tenure, by sex, were calculated by use of Student's $t$ tests. The total number of all injuries and total recordable injuries, as well as the number of injuries per injury severity classification, number of lost work days, and number of restricted work days, were summed by sex. Differences in the distribution of days restricted or days lost for those respective severity categories were analyzed by using Wilcoxon rank sum tests.

Injury rates per 100 person-years, by sex, were calculated as follows: all injury rate, total recordable injury rate, and lost work time injury rate. Odds ratios and 95% confidence intervals for female versus male injury risk, adjusted by standard job category, age category, and tenure category, were calculated by using multivariate logistic regression for all injuries, total recordable injuries, and lost work time injuries. The association of sex with clustering of injuries (multiple injuries per person) was evaluated by use of linear regression.

In addition, injury rates per 100 person-years, by sex, were calculated separately for the acute injuries and the MSD-related injuries. For these 2 categories, odds ratios and 95% confidence intervals for female versus male injury risk, adjusted by standard job category, age category, and tenure category, were again calculated by use of multivariate logistic regression for all injuries, total recordable injuries, and lost work injuries.

Statistics were calculated by SAS, version 8.2, software (SAS Institute, Inc., Cary, North Carolina). All $P$ values were 2 sided, and a value of less than $\alpha = 0.05$ was deemed statistically significant.

**Table 1.** Characteristics of US Aluminum Smelter Employees, by Sex, 1996–2005

| | Male | | Female | | Total | | *P* Value |
|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % | |
| Employees | 8,565 | 92.5 | 692 | 7.5 | 9,527 | 100 | |
| Person-years | 55,034 | 93.7 | 3,688 | 6.3 | 58,722 | 100 | |
| Injuries | 10,691 | 90 | 1,176 | 10 | 11,867 | 100 | |
| Age, years (mean (SD)) | 45.1 (12.2) | | 39.1 (12.2) | | 44.7 (12.3) | | <0.0001 |
| Employee duration, years (mean (SD)) | 18.9 (12.6) | | 12.1 (11.0) | | 18.4 (12.7) | | <0.0001 |

Abbreviation: SD, standard deviation.

This study was approved by the Institutional Review Board at Yale University.

## RESULTS

Over the 10-year study period, 9,527 production employees worked a total of 58,722 person-years at the 6 smelters (Table 1).

Female workers comprised 7.5% of the total employee population and accounted for 6.3% of the person-years. There were a total of 11,867 injury events reported in this cohort during calendar years 1996 through 2005. Of the total injury events, 10% involved female employees, and 90% involved male employees. Injured female workers tended to be slightly younger than injured male workers and had a shorter overall duration of employment at the time of injury.

Of the total hourly workforce, 4,928 employees (51.7%) reported at least 1 injury over the 10-year period of follow-up. Of this injured population, 414 were female workers, and 4,514 were male workers, which represented 59.8% of the female workforce and 52.7% of the male workforce, respectively. Of the 414 women who reported at least 1 injury during the study period, 33% ($n = 138$) reported only 1 injury, 25% ($n = 104$) reported 2 injuries, 14% ($n = 58$) reported 3 injuries, and 28% ($n = 114$) reported more than 3 injuries. Of the 4,514 men who reported at least 1 injury during the study period, 43% ($n = 1,926$) reported only 1 injury, 24% ($n = 1,073$) reported 2 injuries, 14% ($n = 644$) reported 3 injuries, and 19% ($n = 871$) reported more than 3 injuries. Comparison of the percentages of the males and females in the study population who reported multiple injuries was not statistically significant ($P = 0.56$).

The injury rate was higher for females compared with males regardless of whether the analysis included all injuries, only the recordable injuries, or only the most severe injuries, that is, those that resulted in lost work time. Multivariate logistic regression analysis showed that female workers in this industry have a greater risk of sustaining any injury after adjustment for age, tenure, and standardized job category, as well as for sustaining an injury that required medical treatment. In addition, there appears to be an increased risk, though not statistically significant, among females for sustaining an injury that resulted in lost work time. These results are displayed in Table 2.

For the more severe injuries, there was, again, a sex difference, with injuries sustained by female workers resulting in a higher median value of restricted days per event compared with injuries sustained by male workers and a higher median value of lost work days per event compared with injuries to male workers (Table 3).

Dichotomization of the injury types into acute and MSD-related categories for separate analyses showed that females sustained higher rates of both acute injuries and MSD-related injuries. These results are shown in Table 4.

## DISCUSSION

This report is the first to use a large occupational cohort in a single heavy manufacturing industry to explore whether or not a true occupational injury sex disparity exists. Female workers are at greater risk of all injuries than are male workers and, although not statistically significant in our analysis, female workers also appear to be at greater risk of sustaining injuries that result in lost work time compared with their male counterparts. This sex difference in injury risk remained when analyses of acute types of injuries were

**Table 2.** Injury Rates of US Aluminum Smelter Employees, by Sex, 1996–2005[a]

| | Rate/100 Person-Years | Odds Ratio (Female vs. Male)[b] | 95% Confidence Interval |
|---|---|---|---|
| All injuries ($n = 11,867$ injuries) | | | |
| Female | 31.89 | 1.365 | 1.290, 1.445 |
| Male | 19.43 | | |
| Total recordable ($n = 4,527$ injuries) | | | |
| Female | 13.15 | 1.370 | 1.254, 1.498 |
| Male | 7.34 | | |
| Lost work days ($n = 267$ injuries) | | | |
| Female | 1.30 | 1.116 | 0.796, 1.565 |
| Male | 0.40 | | |

[a] Because age did not have a continuous effect, age categories (≤30, >30–40, >40–50, >50–60, >60 years) were used for adjustment. Tenure categories: <20, 20–30, >30 years.

[b] Adjusted by standard job, age category, and tenure category.

**Table 3.** Degree of Injury Severity Determined by Lost and Restricted Work Days[a] Among US Aluminum Smelter Employees, by Sex, 1996–2005

| | Males | Females | *P* Value |
|---|---|---|---|
| Lost work days | | | |
| No. of events | 218 | 49 | |
| Median no. of lost days per event | 35 | 57 | 0.009 |
| 25th–75th percentiles | 14.0–64.5 | 28.0–97.0 | |
| Restricted work days | | | |
| No. of events | 1,638 | 245 | |
| Median no. of restricted days per event | 13.0 | 18.5 | 0.009 |
| 25th–75th percentiles | 5.0–34.0 | 6.0–46.0 | |

[a] The number of lost work days was missing for 6 male and 2 female lost work day cases. The number of restricted work days was missing for 33 male and 3 female restricted work cases.

performed separately from musculoskeletal-related injuries, indicating that the increased risk for injuries is not simply due to a higher propensity for women to suffer musculoskeletal disorders.

Although this study included certain jobs specific only to aluminum smelting operations, the majority of job categories analyzed are found in many other heavy manufacturing industries as well. These include jobs such as crane operators, machinists, mechanical and electrical maintenance, machine operators, and mobile equipment operators. Hence, applicability of the study results extends well beyond the aluminum industry.

There are several factors that may explain the differences observed in injury patterns between male and female aluminum smelter workers. One of the more commonly proposed explanations for differences in injury patterns observed between men and women, especially in the more physically demanding jobs, is the characteristic sex difference in size and physical capacity (24). Historically in heavy manufacturing industries, tools, equipment, working surface heights, and work stations were designed for men of average size. Therefore, the difference in anthropometric measurements between male and female workers may result in female workers conducting work tasks differently from male workers. Thus, very different physical demands may be placed on women of average size than on their average-sized male counterparts (25–27). These physical (work-related and host) factors may explain some of the sex differences observed in the injury pattern of the workforce under study, although we would expect these to manifest primarily in the MSD-related injuries.

Another factor that may explain the difference in injury experience between male and female workers is the sex

**Table 4.** Injury Rates Among US Aluminum Smelter Employees, by Sex and Injury Type, 1996–2005

| | All Injury Rate/100 Person-Years | Odds Ratio (Female vs. Male)[a] | 95% Confidence Interval |
|---|---|---|---|
| Acute | | | |
| All acute injuries ($n = 7,384$) | | | |
| Female | 18.65 | 1.201 | 1.151, 1.295 |
| Male | 12.17 | | |
| Total recordable acute injuries ($n = 2,615$) | | | |
| Female | 5.91 | 1.158 | 1.012, 1.326 |
| Male | 4.35 | | |
| Lost-work-day acute injuries ($n = 93$) | | | |
| Female | 0.46 | 1.097 | 0.512, 2.348 |
| Male | 0.13 | | |
| MSD related | | | |
| All MSD-related injuries ($n = 4,483$) | | | |
| Female | 13.23 | 1.119 | 1.097, 1.311 |
| Male | 7.26 | | |
| Total recordable MSD-related injuries ($n = 1,912$) | | | |
| Female | 7.24 | 1.334 | 1.174, 1.515 |
| Male | 2.99 | | |
| Lost-work-day MSD-related injuries ($n = 174$) | | | |
| Female | 0.84 | 1.285 | 0.783, 2.109 |
| Male | 0.26 | | |

Abbreviation: MSD, musculoskeletal disorder.
[a] Adjusted by standard job, age category, and tenure category.

difference in age and tenure. Messing et al. (28) studied the risk factors associated with injuries in a blue collar workforce of a large Quebec municipality and reported that injured female workers were, on average, younger and less senior than their male counterparts. However, women did not appear to have more severe accidents, as they lost time slightly less often and had shorter lengths of absence in this workforce. This observation was attributed to longer recovery periods following an injury in older male workers. In our study population, injured female workers were also slightly younger and had a shorter duration of employment compared with injured male workers. In contrast, injuries to female workers were more severe as measured by the more frequent need for medical treatment, job restriction, and lost work days following injury. Age and seniority appear to be protective factors against injuries in our study population (22), perhaps because older, more senior workers within a job category may be protected from performing the more physically demanding tasks by the younger workers. Further, the more experienced workers are likely more familiar with the job tasks and therefore able to perform certain tasks more safely. However, in a multivariate model adjusted for age, tenure, and job category, the excess risk persists.

Another possible explanation for our observation that women are at greater risk of injury in the study population could be a combination of an overall increase in injury rate over time and an increase in the percentage of women in the workforce over that same period of time. The percentage of women in our study population increased by approximately 0.15% per year over the 10-year study period; however, the rate of injury decreased by approximately 0.8% per year over the same period of time. Therefore, temporality is not driving the observation.

Work culture or workplace climate has been reported to influence sex disparity in injury risk. Some studies have shown that women may receive less on-the-job safety mentoring from supervisors and coworkers than men receive (18). Male workers also tend to have more autonomy and control at work (29, 30). These factors are likely more evident in industrial workforces traditionally dominated by men. Although not specifically studied, these factors may explain, in part, some of the sex differences in the injury pattern observed in our study population. Other factors, such as balancing the demands of work and family, may also contribute to the difference in injury rate observed between men and women (31).

Although health statistics repeatedly have shown a sex difference in health services usage and symptom reporting, with women more likely to report symptoms and to seek care (32), the results of this study are not likely caused by such a bias in behavior. An increase in injury reporting by women would have resulted in a greater number of injuries of lesser severity, that is, first aid and perhaps medical treatment injury classifications, but would not cause an increase in injuries that require restricted work or lost work time. The results of this study show that female workers had higher rates for all injuries, including the more severe injury categories, which would not be influenced by any sex differential in reporting.

Because of limitations in the available data, this study was unable to evaluate the effects of confounding by individual-level variables such as cigarette smoking, alcohol use, comorbidities or underlying medical problems (e.g., depression), or other factors that have been hypothesized as risk factors for work injuries (33, 34). In addition, the impact of anthropometric differences between the female and male workers on occupational injury risk could not be determined as data, such as height, weight, and other anthropometric measures, were not available for this population. Moreover, measures depicting specific physical demands by job task to further define physical hazards in the work environment and to determine any differential impact on female compared with male workers were also unavailable.

It is possible that inaccuracies in classification of injury case characteristics, namely, nature of injury and injury severity (first aid, medical treatment, restricted and lost work time), may have affected these results. However, the authors have no reason to suspect any widespread or systematic misclassification and therefore find it unlikely that any inaccuracies in classification could explain the most important findings of this study.

Some studies have indicated that women and men within the same jobs and assigned to the same activities do not necessarily perform the same tasks (3, 28) when working within teams, and workers have reported a sex division of labor that may favor either men or women depending on the industry (7). Although this study controlled for job category, this may not have been sufficient to control for task-related risk. That said, there is no reason to believe that female workers perform more inherently risky tasks compared with male workers in the same job category.

The disparity in injury rates could also be explained, at least in part, by a difference in hours worked if females in this industry worked, on average, more hours per day than the male workers. However, other studies indicate that, in fact, female employees tend to work fewer hours per day than do their male counterparts (35, 36). As a consequence of not having the ability to consider the sex difference in actual hours worked per day in this study, the true injury risk in this workforce may be underestimated by our analysis.

Despite the aforementioned limitations, this study shows a clear difference in injury risk and injury severity between male and female workers, thus supporting the hypotheses that females are at higher risk for occupational injury than are male workers in a heavy manufacturing environment and that female workers sustain more severe injuries than do their male counterparts.

As female workers increasingly move into jobs in the heavy manufacturing sector, employers should revisit tool, equipment, and work station design to ensure suitability for a broad population of female workers. Further, taking into consideration potential differences in life experience between new female employees and new male employees, special orientation and/or mentoring programs for females entering these jobs may be beneficial in making those workplaces more sex friendly. Finally, more research attention should be given to the interaction of female employees and their work environment to further explore the extent of and reasons for the apparent sex difference in occupational injury experience.

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## REFERENCES

1. Women's Bureau, US Department of Labor. Women in the labor force in 2006. Washington, DC: US Department of Labor; 2005. (http://www.dol.gov/wb/factsheets/Qf-laborforce-06.htm). (Accessed December 2007).
2. Wootton B. Gender differences in occupational employment. *Mon Labor Rev.* 1997;120(4):15–24.
3. McDiarmid MA, Gucer PW. The ''GRAS'' status of women's work. *J Occup Environ Med.* 2001;43(8):665–669.
4. Nonfatal occupational injuries and illnesses requiring days away from work, 2006. Washington, DC: Bureau of Labor Statistics, US Department of Labor; 2007. (http:/www.bls.gov/news.release/pdf/osh2.pdf). (Accessed December 2007).
5. Chen GX, Hendricks KJ. Nonfatal occupational injuries among African American women by industrial group. *J Safety Res.* 2001;32(4):75–84.
6. Messing K, Punnett L, Bond M, et al. Be the fairest of them all: challenges and recommendations for the treatment of gender in occupational health research. *Am J Ind Med.* 2003;43(6):618–629.
7. Kines P, Hannerz H, Mikkelsen KL, et al. Industrial sectors with high risk of women's hospital-treated injuries. *Am J Ind Med.* 2007;50(1):13–21.
8. Toscano G, Windau J, Knestaut A. Work injuries and illnesses occurring to women. In: *Compensation and Working Conditions*. Washington, DC: Bureau of Labor Statistics, US Department of Labor; 1998:16–23. (http://www.bls.gov/opub/cwc/archive/summer1998art3.pdf).
9. Bull N, Riise T, Moen BE. Mechanisms of occupational injuries reported to insurance companies in Norway from 1991 to 1996. *Am J Ind Med.* 2001;39(3):312–319.
10. Smith PM, Mustard CA. Examining the associations between physical work demands and work injury rates between men and women in Ontario, 1990–2000. *Occup Environ Med.* 2004;61(9):750–756.
11. Daley JR, Root N. Are women safer workers? A new look at the data. *Mon Labor Rev.* 1980;103(9):3–10.
12. Franklin GM, Haug J, Heyer N, et al. Occupational carpal tunnel syndrome in Washington State, 1984–1988. *Am J Public Health*. 1991;81(6):741–746.
13. Islam SS, Velilla AM, Doyle EJ, et al. Gender differences in work-related injury/illness: analysis of workers compensation claims. *Am J Ind Med.* 2001;39(1):84–91.
14. Lipscomb HJ, Dement JM, Loomis DP, et al. Surveillance of work-related musculoskeletal injuries among union carpenters. *Am J Ind Med.* 1997;32(6):629–640.
15. Zwerling C, Sprince NL, Ryan J, et al. Occupational injuries: comparing the rates of male and female postal workers. *Am J Epidemiol.* 1993;138(1):46–55.
16. McCurdy SA, Schenker MB, Lassiter DV. Occupational injury and illness in the semiconductor manufacturing industry. *Am J Ind Med.* 1989;15(5):499–510.
17. Vergara AE, Fuortes L. Surveillance and epidemiology of occupational pesticide poisonings on banana plantations in Costa Rica. *Int J Occup Environ Health*. 1998;4(3):199–201.
18. Kelsh MA, Sahl JD. Sex differences in work-related injury rates among electric utility workers. *Am J Epidemiol.* 1996;143(10):1050–1058.
19. Saleh SS, Fuortes L, Vaughn T, et al. Epidemiology of occupational injuries and illnesses in a university population: a focus on age and gender differences. *Am J Ind Med.* 2001;39(6):581–586.
20. Ore T. Women in the U.S. construction industry: an analysis of fatal occupational injury experience, 1980 to 1992. *Am J Ind Med.* 1998;33(8):256–262.
21. Pollack KM, Sorock GS, Slade MD, et al. Association between body mass index and acute traumatic workplace injury in hourly manufacturing employees. *Am J Epidemiol.* 2007;166(2):204–211.
22. Pollack KM, Agnew J, Slade MD, et al. Use of employer administrative databases to identify systematic causes of injury in aluminum manufacturing. *Am J Ind Med.* 2007;50(9):676–686.
23. Vegso S, Cantley L, Slade M, et al. Extended work hours and risk of acute occupational injury: a case-crossover study of workers in manufacturing. *Am J Ind Med.* 2007;50(8):597–603.
24. Blue C. Women in nontraditional jobs: is there risk for musculoskeletal injury? *AAOHN J*. 1993;41(5):235–240.
25. Vézina N, Courville J. Integration of women into traditionally masculine jobs. *Women Health*. 1992;18(3):97–118.
26. Stevenson JM, Greenhorn DR, Bryant JT, et al. Gender differences in performance of a selection test using the incremental lifting machine. *Appl Ergon.* 1996;27(1):45–52.
27. Punnett L, Bergqvist U. Musculoskeletal disorders in visual display unit work: gender and work demands. *Occup Med.* 1999;14(1):113–124.
28. Messing K, Dumais L, Courville J, et al. Evaluation of exposure data from men and women with the same job title. *J Occup Med.* 1994;36(8):913–917.
29. Hall E. Gender, work control stress: a theoretical discussion and empirical test. *Int J Health Serv.* 1989;19(4):725–745.
30. Bourbonnais R, Mondor M. Job strain and sickness absence among nurses in the province of Quebec. *Am J Ind Med.* 2001;39(2):194–202.
31. Wohl A, Morgenstern H, Kraus D. Occupational injury in female aerospace workers. *Epidemiology.* 1995;6(2):110–114.
32. Verbrugge LM. The twain meet: empirical explanations of sex differences in health and mortality. *J Health Soc Behav.* 1989;30(3):282–304.
33. Smith GS, Kraus JF. Alcohol and residential, recreational, occupational injuries: a review of the epidemiologic evidence. *Annu Rev Public Health*. 1988;9:99–121.
34. Baker SP, Samkoff JS, Fisher RS, et al. Fatal occupational injuries. *JAMA*. 1982;248(6):692–697.
35. Giersiepen K, Eberle A, Pohlabeln H. Gender differences in carpal tunnel syndrome? Occupational and non-occupational risk factors in a population-based case-control study [abstract]. *Ann Epidemiol.* 2000;10(7):481.
36. Burke RJ. Effects of sex, parental status, and spouse work involvement in dual-career couples. *Psychol Rep.* 2000;87(3 pt 1):919–927.