Sleep Problems and Workplace Injuries in Canada

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Study Objective: To investigate the association between sleep problems and risk of work injuries among Canadian workers and to identify working groups most at risk for injuries.
Design: Population-based cross-sectional survey.
Setting: Canada
Participants: Working-age respondents (15-64 years of age) who worked part or full-time in the last 12 months (n = 69,584).
Interventions: None
Methods: This study used data from the Canadian Community Health Survey (CCHS) Cycle 1.1 2000-2001.
Measurements and Results: The main indicator of sleep problems was reporting trouble going to sleep or staying asleep. Stratified logistic regression models were used to calculate odds ratios (OR) and 95% confidence intervals (CI) for the association of sleep problems and work injury after adjusting for potential confounders and for the survey design. Trouble sleeping most of the time was significantly associated with work injury in both men (OR = 1.25, 95% CI = 1.01-1.55) and women (OR = 1.54, 95% CI = 1.25-1.91). The multivariate stratified analysis found that men in trades and transportation jobs (OR = 1.50, 95% CI = 1.09-2.08), women in processing and manufacturing jobs (OR = 2.46, 95% CI = 1.11-5.47), and women who work rotating shifts (OR = 1.71, 95% CI = 1.11-2.64) were at the highest increased risk for work injury associated with trouble sleeping.
Conclusions: Trouble sleeping was associated with an increased risk of work injury. The number of injuries attributable to sleep problems was higher for women compared to men. While most job classes and shift types showed an increased risk of injury, some groups such as women in processing and manufacturing and those who work rotating shifts warrant further investigation and attention for intervention.
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IN 2002, MORE THAN 3 MILLION CANADIAN ADULTS MET THE CRITERIA FOR INSOMNIA, THE MOST COMMON SLEEP DISORDER.[1] AMONG WORKERS, THERE IS a high prevalence of sleeping problems. One review[2] reported that 5% to 29% of non shift workers experienced insomnia symptoms, 30% to 45% reported poor sleep quality, and 7% of men and 13% of women non shift workers had excessive daytime sleepiness. Among shift workers, 29% to 38% experienced insomnia symptoms, while 4% to 5% had excessive daytime sleepiness. The presence of sleep problems can interfere with daily functioning including work tasks leading to injuries.

Sleep problems and work-related injuries are associated with significant medical and financial costs to individuals, medical and workers' compensation systems, and society in general. In the United States (US), the direct medical costs of sleep problems was estimated at $15.9 billion in 1990 US dollars,[3] while the costs of all types of injuries related to sleep problems were estimated in 1988 at between $43.2 to $56.0 billion.[4] In 1994, Leger estimated that there were 5,565 work-related fatalities and 945,000 work-related injuries attributed to sleepiness, leading to a cost of almost $25 billion.[3]

Among worker populations, previous studies show a link between sleep symptoms or disorders and the risk for work injury with, on average, an approximate 2-fold increased risk. This poses risks not only to the workers themselves, but to the general population, for example, in the form of medical mistakes or car accidents. For example, a significant increased risk (OR = 1.6) of traffic accidents associated with habitual snoring was observed among professional drivers[5]; and an increased risk of work injury (adjusted OR = 1.3) with sleep disorders (defined by duration of daily sleep, ''sleeping not well,'' and regular consumption of sleeping pills) among railway workers.[6]

Previous studies are largely limited to investigating the risk of work injury associated with sleep disorders among certain occupations, industries, or work groups such as commercial motor vehicle drivers, railway workers, construction workers, and shift workers. A population-based study comparing the risk between work groups has not been conducted and is an important step in documenting the burden of the problem and to identify at-risk groups for prevention efforts.

Research Questions

The specific research questions for this study were:

- Is there an increased risk for work injuries among workers with sleep problems versus no sleep problem, using a population-based survey sample?
- How does the risk differ by work characteristics including job class, job status, number and type of hours worked per week, and number of jobs worked, adjusted for confounders and covariates? Does the risk differ for men and women?

A commentary on this article appears in this issue on page 577.

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METHODS

Survey Source and Sample

This study utilized data from Statistics Canada's Canadian Community Health Survey Cycle (CCHS) 1.1 2000-2001, a national cross-sectional population health survey. All CCHS data is collected by self reports. As such, clinical diagnoses of sleep disorders, including insomnia, sleep apnea, sleep debt, and hypersomnia were not possible. The CCHS represents approximately 98% of the Canadian population age 12 years and older, excluding those living on Indian reserves or Crown lands, residents of institutions, full-time members of the Canadian Armed Forces, and residents of certain remote regions.[7] A multistage stratified cluster design combined with random sampling methods was used to select a representative sample of the Canadian population.

The study sample was defined as those of working age (15-64 y) who indicated that they worked either full or part-time in the last year. Individuals who reported a non-work related injury (n = 7,343) were excluded from the study leading to study sample that included those who reported a work injury in the survey year and a control group that did not report *any* injury in the survey year. This led to a survey sample of 69,584 respondents comprising 4,099 individuals who reported a work-related injury and 65,485 individuals who did not report any kind of injury. Overall the included weighted sample represented 14,558,678 Canadians, out of a total weighted survey population of 25,787,334.

MEASURES

Definition of Work Injury

Individuals who reported an injury in the past 12 months that was serious enough to limit normal activities and who also reported that this injury occurred while working on a job or business, or occurred at an industrial or construction site or a farm where considered to have a work injury. An additional question that asked about repetitive strain injuries at work was not included in our definition of work injury as repetitive strain injuries were not hypothesized to be related to sleep problems.

Independent Variables

The principal independent variable was derived from the question, "How often do you have trouble going to sleep or staying asleep?" with 3 possible responses: "never," "sometimes," and "most of the time." This item is used by Statistics Canada to report the prevalence of insomnia in the Canadian population.[1] The response was defined categorically as (1) never any trouble sleeping, (2) trouble sleeping some of the time, and (3) trouble sleeping most of the time. While there is no consistent method of defining insomnia or sleep problems in epidemiological studies, a review from Ohayon[8] found that measures based on sleep frequency, such as the question on trouble sleeping in the CCHS, were the most common measures used in epidemiological studies.[8]

In secondary analyses, the following additional sleep problem measures were also investigated:

- Number of hours spent sleeping per night (categorical variables ranging from < 3 h to ≥ 9 h);
- The frequency that sleep is refreshing (most of the time, sometimes, never);
- How often it is difficult to stay awake (most of the time, sometimes, never); and,
- Sleeping pills taken last month (yes/no);

Secondary sleep problem measures that were associated with work injury at the bivariate level were investigated further at the multivariate level.

Covariates

Based on the availability of variables in the CCHS, 4 categories of covariates were examined:

1. Demographic variables (gender, age, ethnicity, marital status, province of residence);
2. Socioeconomic variables (education, household income, Canadian immigrant status, urban versus rural geographic location).
3. Work characteristics (job class, type of shift, usual hours worked, self-perceived work stress, number of weeks worked per year, multiple job status); and
4. Health measures (self-perceived health status, self-perceived life stress, number of chronic conditions, body mass index, type of smoker, alcohol consumption).

Statistical Analysis

All analyses were stratified by gender. For exploratory analyses, frequencies were calculated and tested for significance using cross tabulations and χ^2 tests. Correlations among all variables were also assessed. Simple logistic regression for binary outcomes (i.e., yes versus no for work injury) was used to investigate the association between the independent variables of interest (sleep problems as well as the secondary indicators of sleep problems) and the dependent variable of interest (work injury) as well as each covariate. Covariates related to work injury at the bivariate level (i.e., 95% CI did not include "one") were retained for investigation in multivariable models. Each sleep variable was entered into a separate model.

Covariates were adjusted for by sequentially adding 3 conceptually related groups of variables (demographic, socioeconomic, and work and health variables) in the multiple logistic regression models. Covariates that remained related to work injury in the third model (i.e., the 95% CI did not cross "one") were retained in the final explanatory model, unless it was predetermined that the variable should always be included (e.g., age, occupation, shiftwork) based on the preexisting literature or on conceptual grounds.

Further analyses were stratified by job class, type of shift, and number of hours worked as we hypothesized that these work characteristics could modify the relationship between trouble sleeping and work injury. For example, we hypothesized that the association between sleep problems and work injury would be higher in individuals who worked > 40 h/week compared to working part-time hours.

SAS software version 9.1 and Stata/SE 10.0 were used for the data analyses. Sampling weights and variance estimates derived from replicate bootstrapped weights were applied to all analyses in order to create a sample representative of Canadian workers and to adjust for the sample design.[9] For all analyses,

confidence limits of 95% were used as the level of statistical significance.

In addition to the regression analyses, the adjusted population attributable fraction (AF_p) was derived. The adjusted population attributable fraction (AF_p) is a standard epidemiologic measure used to estimate how much of the outcome (occupational injuries) that would have been prevented if the exposure (trouble sleeping) was zero in the sample.[10]

The AF_p is derived from the following equation:

$$AF_p = P_C*[(OR-1)/OR]$$

Where P_C is the exposure prevalence (i.e., the sleep problem of interest) in the overall population and the OR is the odds ratio from the final fully adjusted model. The number of work injuries that could be prevented then can be directly calculated by multiplying the AF_p by the total number of work injuries in the sample.

Ethical Considerations

Ethics approval (Certificate # B06-0749) for this study was obtained from the University of British Columbia's Behavioural Research Ethics Board.

RESULTS

The final weighted study sample of 14,558,678 working Canadians represented 56.5% of the original CCHS survey population. Fifty-two percent of the study sample was male; 86% identified themselves as White; and 26% were between the ages of 40-49. Almost 8% of males and 4% of females reported a work injury, while 9% of males and almost 14% of females reported trouble sleeping most of the time. The percentage of workers reporting a work injury increased with self-reported trouble sleeping and was highest among those who slept 3-6 h/night (Table 1). Worker injuries were also more likely in the younger age groups, among those of common-law and single martial status, of aboriginal ethnicity, and those with less than high school, high school, or trade qualifications. Individuals in trades or transport, agricultural or forestry, and manufacturing occupations reported a high work injury rate; as did those in regular night and rotating shifts and those who worked long hours. High levels of work stress, fair or poor self-reported health status, and the presence of a chronic condition were also associated with work injuries, as was being a regular smoker or former drinker (Table 1).

In bivariate logistic models, all sleep problem variables were significantly associated with work injury with the exception of taking a sleeping pill (results not shown). At the multivariate level, the variables for difficulty staying awake and never finding sleep refreshing were not statistically significant and had odds ratios close to one. Final adjusted models were therefore based on trouble sleeping and hours spent sleeping as the primary variables of interest.

The following covariates were not associated with work injury (95% CI included "one") at the bivariate level and were omitted from further analyses: body mass index, self-perceived life stress, number of weeks worked per year, and multiple job status. During the model building process the following variables were not associated with work injury (95% CIs included

Table 1—Description of study sample by sleep, sociodemographic, health, and work characteristics

	Men	Women
	Weighted % (% of category reporting work injury)	Weighted % (% of category reporting work injury)
Full sample	51.5 (7.5)	48.5 (3.6)
Principal Dependent Variables		
Trouble sleeping		
Most of the time	9.3 (10.2)	13.6 (6.1)
Sometimes	31.5 (8.0)	37.0 (3.9)
Never	59.2 (6.8)	49.5 (2.8)
Hours spent sleeping		
Less than 3 hours	0.2 (7.9)	0.2 (4.9)
3 to < 5	3.0 (11.1)	2.6 (5.7)
5 to < 6	8.4 (10.0)	7.4 (6.2)
6 to < 7	26.4 (7.3)	22.3 (3.8)
7 to < 9	57.9 (7.0)	62.1 (3.1)
9+	4.1 (8.7)	5.4 (4.1)
Independent Variables		
Age		
15-19	8.4 (7.7)	9.0 (3.4)
20-29	21.3 (10.1)	21.5 (4.5)
30-39	24.5 (8.0)	24.4 (3.5)
40-49	25.7 (6.7)	26.9 (3.5)
50-59	16.7 (5.3)	15.5 (3.1)
60-64	3.5 (6.2)	2.7 (2.4)
Marital Status		
Married	50.7 (6.3)	50.3 (2.8)
Common-law	10.5 (9.8)	10.9 (4.3)
Widowed	0.4 (5.5)	1.5 (4.5)
Separated/Divorced	6.2 (8.1)	9.1 (4.3)
Single	32.1 (8.8)	28.3 (4.6)
Ethnicity		
White	85.5 (7.9)	86.3 (3.8)
Aboriginal	0.9 (11.1)	0.9 (7.3)
Black/African American	1.8 (5.7)	2.2 (2.2)
Asian	9.4 (4.4)	8.2 (1.7)
Other/Mixed Ancestry	2.8 (7.5)	2.8 (3.5)
Education		
Bachelor or higher	19.6 (2.8)	15.3 (2.0)
College/univ certificate	19.6 (6.8)	19.2 (3.8)
Some college/univ	18.3 (7.7)	25.6 (4.2)
Trade school	9.0 (10.5)	10.1 (4.4)
High school	13.6 (9.1)	8.6 (4.2)
Less than high school	20.1 (8.9)	21.3 (3.6)

Table 1 continues on the following page

The income quintile variable is based on the entire CCHS sample. Chronic conditions consist of 27 chronic conditions spanning musculoskeletal, respiratory, cardiovascular, cancer, diabetes, and other chronic conditions. For the variable alcohol consumption, regular drinker is defined at one or more drinks a month, occasional drinker as alcohol consumption in the past 12 months but not every month, former drinker as previous alcohol consumption, but not in the past 12 months. Province of residence is also included as an independent variable, but descriptive results are not shown.

Table 1 *(continued)*—Description of study sample by sleep, sociodemographic, health, and work characteristics

	Men	Women
	Weighted % (% of category reporting work injury)	Weighted % (% of category reporting work injury)
Occupation		
Management	12.2 (3.5)	8.4 (3.7)
Professional	13.3 (3.4)	18.6 (3.2)
Technician	11.3 (5.2)	5.5 (4.7)
Admin/clerical	3.9 (2.9)	21.3 (1.8)
Sales/service	18.4 (7.2)	29.3 (4.0)
Trades/transport	23.7 (11.7)	3.8 (6.5)
Farm/forestry/fish	4.8 (10.9)	1.7 (5.4)
Processing/manufacturing	5.8 (12.2)	3.7 (5.0)
Other	6.6 (8.5)	7.7 (4.5)
Type of shift		
Regular daytime	68.7 (7.1)	70.5 (3.2)
Regular evening	5.6 (7.6)	6.8 (3.3)
Regular night	3.0 (13.1)	1.9 (5.7)
Rotating shift	10.3 (8.8)	9.1 (6.0)
Split shift	1.7 (5.7)	1.7 (4.0)
Irregular Schedule	1.1 (8.5)	1.0 (4.0)
Other	9.4 (7.7)	8.7 (4.4)
Usual hours worked in week of survey		
1 to 25	7.8 (5.7)	17.1 (2.6)
21-35	9.9 (5.5)	25.1 (3.3)
36-40	35.3 (7.6)	35.6 (3.8)
41-60	38.7 (7.7)	20.4 (4.2)
61+	8.4 (10.3)	2.9 (5.5)
Self-perceived work stress		
No work stress	10.6 (6.3)	9.8 (2.3)
Not very stressful	18.3 (7.4)	17.7 (3.0)
A bit stressful	39.6 (7.5)	38.6 (3.3)
Stressful	25.3 (7.5)	26.8 (4.1)
Extremely stressful	6.2 (10.5)	7.2 (6.6)
Chronic conditions		
None	46.6 (6.2)	35.5 (2.8)
One	28.8 (7.5)	28.1 (2.9)
Two	14.8 (9.1)	18.1 (4.8)
Three or more	9.7 (11.0)	18.4 (6.3)
Type of smoker		
Regular	27.0 (10.8)	22.0 (5.9)
Occasional	5.2 (7.2)	5.4 (3.5)
Former	22.4 (6.4)	19.9 (3.1)
Never smoked	45.4 (6.1)	52.8 (2.9)
Alcohol consumption		
Regular drinker	74.0 (7.6)	59.0 (3.5)
Occasional drinker	13.1 (8.0)	24.3 (3.8)
Former drinker	8.1 (8.5)	9.6 (5.1)
Never drank alcohol	4.8 (4.4)	7.1 (1.5)
Weighted sample	Weighted N = 7,491,435	Weighted N = 7,067,183
Survey sample size	34,045	35,539

The income quintile variable is based on the entire CCHS sample. Chronic conditions consist of 27 chronic conditions spanning musculoskeletal, respiratory, cardiovascular, cancer, diabetes, and other chronic conditions. For the variable alcohol consumption, regular drinker is defined at one or more drinks a month, occasional drinker as alcohol consumption in the past 12 months but not every month, former drinker as previous alcohol consumption, but not in the past 12 months. Province of residence is also included as an independent variable, but descriptive results are not shown.

"one") after adjusting for other covariates and were removed from the final multivariate model: self perceived health, household income, geography (rural vs. urban), and Canadian immigrant status. Ethnicity was collapsed, for parsimony, to a 3-category variable of "White," "Aboriginals," and "Other," as Blacks, Asians, and those of other or mixed ancestry all had similar risk of work injury. The final multivariate models controlled for: age, ethnicity, marital status, self-perceived work stress, job class, usual hours worked, type of shift, education, province, number of chronic conditions, type of smoker, and alcohol consumption. Due to missing data on the retained variables, the final models were reduced in sample size by 5% to 32,604 men and 34,043 women.

Sleep Problems

In the final adjusted models (Table 2), an increased odds of work injury was observed for workers reporting trouble sleeping most of the time, compared to those who never have trouble sleeping, for both men and women (OR = 1.25, 95% CI = 1.01-1.55; and 1.54, 95% CI = 1.25-1.91, respectively). Trouble sleeping sometimes was also associated with work injury for women (OR = 1.26, 95% CI = 1.03-1.54). The association between hours of sleep and work injuries was less clear, but the odds of work injury was elevated for women who sleep 5 to 6 h/night, compared to women who sleep 7 to 9 h/night (OR = 1.59, 95% CI = 1.15 = 2.00).

Stratified Results

Job class was a larger effect modifier of this relationship for women (Table 3). In particular, trouble sleeping was associated with work injury for women in processing or manufacturing jobs (OR = 2.46, 95% CI = 1.11-5.47) and professional occupations (e.g., teaching, medicine, nursing) (OR = 1.70, 95% CI = 1.11-2.59), while trouble sleeping was associated with work injury for men in trades or transportation occupations only (OR = 1.50, 95% CI = 1.09-2.08).

Both men and women working a daytime shift had an increased odds of work injury associated with trouble sleeping (OR = 1.58, 95% CI = 1.21-2.05; and 1.46, 95% CI = 1.14-1.86, respectively). Additionally, women had a significant increased odds of work injury associated with working rotating shifts (OR = 1.71, 95% CI = 1.11-2.64).

The highest odds of work injury associated with trouble sleeping were seen in women who worked part-time hours (1-25 h/week; OR = 1.70, 95% CI = 1.01-2.87), those that worked full-time hours (36-40 h/week; OR = 1.56, 95% CI = 1.15-2.12) and overtime hours (41-60 h/week; OR = 1.59, 95% CI = 1.07-2.37); while for men, the highest risk was seen in full-time hours (36-40 h/week; OR = 1.71, 95% CI = 1.20-2.42). No association between trouble sleeping and work injuries was observed for men or women who worked very long hours.

Table 2—Multivariate results for risk of work injury associated with sleep problems

	Men		Women	
Trouble sleeping*^	Unadjusted OR (95% CI)	Adjusted OR (95% CI)	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
Never (ref)	1.00	1.00	1.00	1.00
Sometimes	1.19 (1.05, 1.35)	1.07 (0.94, 1.22)	1.41 (1.17, 1.71)	1.26 (1.03, 1.54)
Most of the time	1.55 (1.27, 1.89	1.25 (1.01, 1.55)	2.27 (1.84, 2.80)	1.54 (1.25, 1.91)
Weighted population	7,489,477	7,219,813	7,065,807	6,813,675
Sample size	34,028	32,604	35,529	34,043
Number of hours spent sleeping each night*^				
Less than 3 h	1.14 (0.30, 4.31)	0.82 (0.20, 3.35)	1.59 (0.44, 5.72)	0.82 (0.18, 2.98)
3 to < 5	1.67 (1.31, 2.13)	1.12 (0.84, 1.50)	1.88 (1.32, 2.68)	1.23 (0.80, 1.75)
5 to < 6	1.49 (1.22, 1.81)	1.12 (0.91, 1.38)	2.04 (1.59, 2.62)	1.59 (1.15, 2.00)
6 to < 7	1.05 (0.93, 1.19)	0.94 (0.82, 1.17)	1.21 (0.99, 1.48)	1.14 (0.91, 1.36)
7 to < 9 (ref)	1.00	1.00	1.00	1.00
9+	1.27 (0.92, 1.75)	1.07 (0.75, 1.54)	1.33 (0.91, 1.92)	1.25 (0.85, 1.88)
Weighted population	7,484,272	7,216,988	7,063,228	6,813,674
Sample size	33,994	32,579	35,507	34,043

*Each sleep variable was entered in separate models; ^Each model was adjusted for age, ethnicity, marital status, self-perceived health, self-perceived work stress, job class, usual hours worked type of shift, education, province, number of chronic diseases, type of smoker, and alcohol consumption.

Adjusted Population Attributable Fraction

The attributable fraction of work injuries related to trouble sleeping most of the time was found to be 1.9% for men and 4.8% for women. This study found 561,996 work injuries in men and 255,137 work injuries in females. This suggests that if medical interventions or workplace policies could help reduce sleeping problems among workers who experience these symptoms most of the time, there would be the potential to prevent 10,677 and 12,247 work injures in men and women respectively.

DISCUSSION

Previous studies have found an increased risk of work injuries due to various sleeping problems in certain high risk industries. This study established that this association is present at the population workforce level among Canadian workers. This study found that work injury is associated with trouble sleeping most of the time as well as trouble sleeping sometimes, and that this association is stronger among women compared to men.

Sleep Problems

Prior studies have established that sleeping problems, both diagnosed and self-reported, as well as various definitions of sleeping problems, are associated with both injury and fatalities at work.

No previous research has studied the association of self-reported sleeping problems and work injury based on the entire Canadian working population. Furthermore, no studies could be identified that defined sleeping problems in the same manner as the current study making it difficult to make comparisons across studies. However, several studies have examined this association using self-report data.

In a study most comparable to the current investigation, Akerstedt and colleagues[11] found a significant increased risk between self-reported difficulty sleeping and fatal work accidents (OR = 1.89) in a prospective study. A series of studies from Chau and colleagues found a significant association of sleep disorders (defined by duration of daily sleep, ''sleeping not well,'' and regular consumption of sleeping pills) and work injury in railway workers[6] and construction workers.[12] One study, however, found that subjective sleepiness just before the injury was associated with a significantly lower risk of injury.[13]

Studies have also found an increased risk of work injury or fatalities using other measures of sleeping problems including hypersomnolence, habitual snoring, and sleep disordered breathing among truck drivers,[5,14,15] as well as insomnia in manufacturers[16] and excessive daytime sleepiness among workers in an industrial plant[17] and nurses.[18] Despite differences in study samples and variable definitions there is consistent evidence, including evidence from this population-based workforce study, of a link between sleep problems and work injury.

When examining the number of hours slept per night and the association with work injury, Choi and colleagues found that sleeping < 7.5 h/night increased the risk for injuries and sleeping > 8.5 h/night was associated with nonsignificant increase in risk for injury.[19] Similarly, Gabel and Gerberich found an increased risk for injury among veterinarians who slept < 6 h/night.[20] Seven to 8 hours of sleep is considered optimal for one's health[21]; sleeping too little is likely associated with increased injury due to the inability to focus and concentrate, but the relationship between too much sleep and injury is not obvious. A recent study of British civil servants[22] found that > 8 h sleep was associated with an increased risk of mortality similar to those with < 7 h sleep/night. Mechanisms for "too much sleep" are not well understood yet.

In the current study, hours slept per night was highly correlated with trouble sleeping, with more than 50% of individuals sleeping < 5 h/night and only 7% of individuals sleeping ≥ 7 h/night reporting trouble sleeping most of the time. However, our study found inconsistent support for a dose-response relation-

Table 3—Multivariate* analysis of the effect of trouble sleeping on work injury stratified by job class, type of shift, and hours worked

Stratification Variables	Men	Women
	OR for trouble sleeping on work injury (95% confidence interval)	
Job Class		
Management	0.75 (0.32, 1.76)	0.89 (0.42, 1.90)
Professional	1.36 (0.48, 3.83)	1.70 (1.11, 2.59)
Technologist	1.00 (0.53, 1.87)	1.38 (0.52, 3.65)
Admin/finance/clerk	3.09 (0.60, 15.81)	0.99 (0.55, 1.78)
Sales/service	1.39 (0.83, 2.34)	1.57 (1.13, 2.18)
Trades/transport	1.50 (1.09, 2.08)	1.31 (0.58, 2.96)
Farm/forestry/fishing	1.18 (0.72, 1.94)	2.61 (0.97, 7.01)
Processing/manufacturing	0.64 (0.36, 1.11)	2.46 (1.11, 5.47)
Other	1.59 (0.79, 3.22)	1.97 (1.02, 3.82)
Shift Type^		
Daytime	1.58 (1.21, 2.05)	1.46 (1.14, 1.86)
Evening	0.83 (0.32, 2.11)	1.52 (0.68, 3.38)
Night	0.83 (0.40, 1.76)	1.22 (0.38, 3.93)
Rotating shift	1.32 (0.85, 2.05)	1.71 (1.11, 2.64)
Split shift	1.00 (0.13, 7.62)	2.49 (0.79, 7.81)
Irregular schedule	0.70 (0.36, 1.37)	1.13 (0.60, 2.14)
Hours Worked Per Week		
1 to 25	0.59 (0.29, 1.22)	1.70 (1.01, 2.87)
26-35	1.20 (0.59, 2.44)	1.41 (0.94, 2.09)
36-40	1.71 (1.20, 2.42)	1.56 (1.15, 2.12)
41-60	1.30 (0.95, 1.76)	1.59 (1.07, 2.37)
61+	0.83 (0.50, 1.37)	0.95 (0.40, 2.23)

*Adjusted for age, ethnicity, and education, presence of a chronic disease; ^On call could not be assessed due to small cell sizes

ship between hours of sleep per night and work injury. Elevated odds of work injury among men who slept between 3 to < 6 h/night or > 9 h/night were attenuated in final adjusted models. Similarly, an elevated odds of work injury for women who slept < 7 h or ≥ 9 h were attenuated in the final adjusted models with the exception of an elevated odds ratio for women who slept 5 to < 6 h/night, suggesting that sociodemographic, work, and health characteristics are confounders of the relationship between sleep hours and work injury. Indeed, the health variables used in this study were strongly associated with hours sleeping and the inclusion of these variables attenuated the relationship between hours slept and work injury. Workers with compromised health may also reduce their work hours thereby reducing their exposure time for injury. The lack of an effect for the least hours of sleep per night may also be due to the smaller sample size as only 3.2% of men and 2.8% women reported sleeping ≤ 5 h/night.

We did not find statistically significant results in the multivariate analysis for the other sleep variables—difficulty staying awake, never find sleep refreshing, and taking a sleeping pill—indicating that these measures did not have an independent effect on work injuries after accounting for demographic, work characteristics, and health variables. These other variables may be measuring sleep problems that have a different etiology than trouble sleeping and hours of sleep. Taking sleeping pills may be associated with counteracting effects on work injury. Taking sleeping pills may be a response to other sleep problems and if effective might reduce the risk of work injury. On the other hand, taking sleeping pills may also be a response to work injury. Given the cross-sectional nature of the data, we were not able to tease apart this relationship.

Stratified Results

Previous research has not examined the differences in risk of work injury associated with trouble sleeping among different work groups. This analysis revealed that different job classes were associated with work injury and that this association differed by gender. Job classes in which there was a high risk of work injury for trouble sleeping were trades and transportation jobs for men and processing or manufacturing and professional jobs for women. Job classes that are not commonly thought to be at risk for injury associated with sleep problems showed evidence of increased risk, such as sales and service jobs among both genders. These results suggest it is important to investigate a broad range of occupations and not just trade or transportation occupations as was done in previous research. Notably, women in professional occupations were found to have a strong association between trouble sleeping and work injuries. A high proportion of women in professional occupations work in health care (e.g., nursing, long-term care), work characterized by high job demands, long hours, and a high risk of work injury.[23,24] For these women, sleep problems may interact with these job characteristics to create an additional risk of work injury.

Differences in risk of work injury associated with sleeping problems among different shift types and work hours have been examined in only a few studies. Previous work has found an increased risk for injury among rotating shift workers[8,25,26] and long work hours.[27,28] Our study substantiates both of these findings although among shift workers, a significant increased risk for work injury was found only among women.

Shift workers are a unique workforce; the nature of their work may actually cause sleep problems.[26] Sleep problems in shift workers, in turn, leads to an increased risk for workplace injury. Boivin et al. suggest this increased risk is seen among women because of factors such as marital status, the number of children in the house, and family responsibilities that can affect a shift worker's quality of life and impede and restrict sleep, further contributing to the problem.[29] It is hypothesized that an increased risk for work injury associated with sleep problems may not have been found in evening and night shift types for men because of self-selection into those shift types or a healthy worker effect where those who cannot contend with evening and night shifts switch to daytime shifts.

Gender Differences

Although most previous studies have not investigated sleeping problems using a similar outcome measure, many have reported on gender differences in the risk of work injury associated with sleeping problems. Similar to previous studies, the current study found that women have a higher risk for injury associated with sleep problems compared to men. Among small-scale manufacturing businesses, Nakata and colleagues found higher odds ratios for the risk of injury associated with

insomnia in women (OR = 1.9 vs. 1.5 for men).[16] Ulfberg and colleagues found higher odds ratios among those with obstructive sleep apnea as well as sleep disordered breathing (the OR for work accidents among men was 1.7 and for women 4.3 compared to participants from the general population).[30] Not all studies show a higher risk in women: for example, Young and colleagues found a significant association of sleep disordered breathing and motor vehicle accidents among men but not women.[31]

Strengths and Limitations

This was a population-based study, representative of the Canadian population that included a broad range of covariates in the analysis. Despite this, there are several limitations to this study. This study was cross-sectional, and causation and the temporal order of sleep problems and injury cannot be determined. It is possible that sleep problems could have developed as a result of the work injury. The cross-sectional study design may explain the lack of an association between taking sleeping pills and work injury. While longitudinal studies are needed to disentangle the temporal and causal relationship between sleep problems and work injuries, this population-based nationally representative survey provides evidence of an association to justify further research. Due to the nature of the questions on sleep problems in the CCHS, there were no clinically diagnosed outcome measures of sleep disorders such as insomnia or sleep apnea based on standardized criteria such as the DSM-IV, and our study relied on measures of frequency of sleep used in most epidemiological studies of sleep problems. This study also preformed multiple comparisons in the stratified models, and as such there is a higher likelihood of Type I error occurring (i.e., a false positive). All data in the CCHS were based on self-reports, and information may have been under- or overestimated. This bias would underestimate the observed relationship between sleep problems and work injury if sleep problems and work injury were under reported, but overestimate the relationship if sleep problems and work injury are overreported. Due to the nature of the data, we could not desegregate the job class variable to assess the risk associated with more finite job classes such as in the transportation industry alone. Finally, as discussed by Tjepkema,[1] certain variables known to be associated with sleeping problems, such as sleep hygiene habits and caffeine intake, were not available in the CCHS and could not be included in the models. This may have resulted in an overestimation of some of the associations,[1] but the model includes many health-related variables that would have been highly correlated with uncontrolled covariates or confounders.

CONCLUSIONS

This study showed that Canadian workers are at an increased risk for injury at work associated with sleep problems and that the number of injuries attributable to sleep problems is higher in women. An increased risk for work injuries associated with trouble sleeping is found in most job classes. Within the Canadian workplace up to 23,000 worker injuries could be prevented with the placement of effective interventions. Future research should investigate methods of preventing both sleep problems in workers as well as work injuries associated with sleep problems.

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