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A Case-Control Study of Occupational Injuries for Consecutive and Cumulative Shifts Among Hospital Registered Nurses and Patient Care Associates

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Abstract

Nontraditional work shifts for hospital registered nurses and patient care associates and associated injuries were examined through a case-control study. Inpatient care requires that many staff work nontraditional shifts, including nights and 12-hour shifts, but some characteristics remain unexplored, especially consecutive shifts. A total of 502 cases (injured workers) were matched to single controls based on their hospital, unit type, job type, gender, and age (± 5 years). Conditional logistic regression was used for the analysis, controlling for weekly hours scheduled. For both, consecutive shifts of 2 or more days and some various cumulative shifts over a week and month period, especially night shifts, were associated with increased odds of injury. More investigations on the phenomenon of consecutive shifts are recommended. Additionally, the assessment of shift policy and subsequent injury outcomes is necessary before implementing intervention strategies.

Employees in the health care industry consistently experience a high number of workplace injuries. This fact is especially true for direct care support staff (i.e., certified nursing assistants [CNAs} or patient care associates [PCAs]); their incident rate ranks third for a major job group behind laborers/freight workers, and truck drivers (Bureau of Labor Statistics, 2012a). Using private industry data from 2010, the most recent year national data is available, the incidence of injuries was 125.1 per 10,000 full-time workers among to registered nurses (RNs) and 459.6 per 10,000 full-time workers among PCAs (Bureau of Labor Statistics, 2012b). RNs and PCAs also suffer a disproportionately high percentage of musculoskeletal injuries with more than half the injuries reported as sprains and strains (Bureau of Labor Statistics, 2012b; Ando et al., 2000). Moreover, RNs and PCAs report

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significant lost work days with 7 and 6 median lost days from work, respectively (Bureau of Labor Statistics, 2012b).

A variety of workplace practices and policies may affect occupational injury rates for direct patient care staff. These patterns include changing staffing ratios by lowering RN staffing (Aiken, Clarke, Sloane, Sochalski, & Silber, 2002); Aiken et al., 2001), substituting 10 or 12 hour shifts for traditional 8 hour shifts (Bendak, 2003), long hours and the use of overtime during high patient census (Bendak, 2003; Caruso, 2006; Dembe, Delbos, & Erickson, 2009; Lipscomb, Trinkoff, Geiger-Brown, & Brady, 2002;) and instituting on call status for some units (Trinkoff, Le, Geiger-Brown, Lipscomb, & Lang, 2006). Although shift length and overtime patterns related to subsequent occupational injury rates have been a recent focus of investigation (National Institute for Occupational Safety and Health, 2004), other patterns such as consecutive shifts and cumulative work, not including overtime have received less attention.

Consecutive shifts, working several consecutive days in a row due to overtime or to earn increased consecutive days of, are a recent trend that may imapct injury rates (Trinkoff, Geiger-Brown, Brady, Lipscomb, & Muntaner, 2006). These shifts have become more popular as health care workers try to accommodate 12-hour shifts and receive enough time off for family and other responsibilities (Alspach, 2007). Although consecutive days of work and resulting increased occupational injury risk has been explored, the ability to measure the impact of consecutive shifts accurately is limited because administrative data and detailed, accurate work schedules are difficult to access.

Cumulative shifts are the number of shifts worked and cumulative hours are the corresponding hours worked in a given time period. Both cumulative shifts and cumulative hours are noteworthy when evaluating occupational injury because shifts vary from in length and duration of exposure to workplace hazard and cumulative hours measure total hours exposed to the workplace. Although many studies have examined excessive hours and overtime as described above, an incremental evaluation of the impact of increasing shifts and hours in a given time period on occupational injury rates has not been adequately conducted.

The purpose of this study is two-fold. First, consecutive shifts worked by direct patient care providers were examined in relation to occupational injury. A case-control design was employed using hospital administrative injury and work history data and matching participants on hospital, unit type, gender, and age. Second, this study will evaluate the contribution of cumulative shifts and cumulative hours on occupational injury rates in a two durations, 7 days and 28 days. The researchers hypothesize that the odds of an injury are increased as the number of consecutive days worked, cumulative shifts and cumulative hours increases. Finally, other shift factors such as 12-hour shifts, and both day and night were evaluated for their respective contribution to the impact of consecutive days and cumulative hours on occupational injury rates.

Methods

Study Design

This study is a cross-sectional nested case-control analysis of administrative data consisting of integrated injury and staffing data for workers in patient care units of two large hospitals collected from 1 January to 31 December 2008 to examine the relationships between consecutive days, cumulative shifts and cumulative hours and occupational injuries. This study is part of the inaugural project for the Harvard School of Public Health Center for Work, Heath, and Wellbeing and was conducted in the metropolitan Boston area. The goal of the overall project was to explore how policies, programs and practices on the hospital units impact the work and health of individuals employed on those units. All research protocols were approved by the applicable institutional review board for protection of human subjects.

Integrated Injury and Staffing Data

For this study the researchers used three employee-related administrative data sources from these hospitals: (1) a Human Resources database (information on the number and types of jobs, job role, worker overtime, absences, paycheck and demographics); (2) the staffing database, which includes all scheduled and worked shifts for all workers; (3) the Occupational Health Services database consisting of all incident reports and worker's compensation claims. A full-time research information systems specialist combined these data bases into a single database for administrative and research purposes.

Human Resources data was used to identify participating Patient Care Services units using the unit cost center code. Eligible employees were found if they were either assigned to that unit as their primary work unit or could be found working on the unit from their paycheck data. Paycheck data was also used to filter the cohort for eligible employees. The staffing database for Patient Care services provided detailed shift and acuity data. Shift codes were employed by the units and customized based on unit needs. An algorithm was created for each code to describe hours worked and shift. For the purposes of this study, only shifts greater than 4 hours were included in analysis. The data generated from paychecks and shifts were routinely updated and corrected for accurate reporting of shifts worked.

The Occupational Health Services Injury database included all reports of injury and information on worker's compensation claims. For the Occupational Health Service database, all injured workers report work-related incidents by completing either a hard copy form or an intranet-based form. All incidents were collected by Occupational Health Services and entered into the Occupational Health Worker's Compensation database. Worker incidents resulting in injury were recorded regardless of whether or not they were mandated as recordable for Occupational Health and Safety Administration (OSHA) purposes (i.e., requiring medical treatment, lost days or restricted work). Injuries were matched to the individual worker using unique identifiers. All data were de-indentified from the integrated database before analysis.

Sample of Patient Care Workers

The integrated database included data on nurses and PCAs who worked for more than 20 hours per week from a total of 66 units in the Patient Care Services Departments at the two hospitals (37 at one hospital and 29 at the other). Two direct patient care job role groups were identified using department expenditure codes, RNs and unit support staff for patient care known as Patient Care Associates (PCAs). The greater than 20 hour per week requirement minimized the possibility of work exposure from other jobs or hospitals. Additionally, the few temporary and agency staff found on the units were excluded due to the temporary nature of their work on any given unit. Agency staff may work greater than 20 hours but typically did not work greater than 3 months on any unit and temporary workers generally did not meet the 20 hour requirement on a unit. A total of 5080 workers were part of the study. The final cohort was coded with study identification numbers and all identifying information was removed to protect the identity of the worker.

For matching purposes, units were next grouped by type of unit based on several characteristics including adult, pediatric or mixed population, and acuity level (i.e., intensive care, cardiac stepdown and medical/surgical units). Acuity of the patient population was confirmed by examining acuity data for each unit. Prior to analysis, unit names were replaced with identification numbers. Four unit categories were created for the purpose of reporting results.

Case and Control Selection

From the cohort of workers, cases were selected from those who had reported an injury incident during 2008. Excluded incidents were those lacking a direct link to a workplace event such as exposures to infectious substances such as aerosolized agents, or to noise, skin complaints and systemic complaints. Blood borne pathogen exposures due to sharps injuries were also excluded. If a worker in the cohort worked in more than one unit, the unit where the worker was assigned on the day of the incident was used as the unit for the study. Additionally, if the injured worker had more than one incident, one of those incidents was randomly selected from the list for inclusion.

Controls were identified by matching the injured workers with similar demographic characteristics in their hospital (i.e., unit type, job type, gender and age +/− 5 years) at a ratio of one case to one control. All controls worked the same day that the injury occurred to the cases. Because controls were matched to case workers by examining if they worked the day of injury, a case could act as a control for another injury at a different time and if demographic characteristics matched the latter case. The researchers did not match on hours worked each week (i.e., full-time equivalents [FTEs]) because hours can fluctuate during the year based on an individual staff member' preference; also the FTE listed in the database may not accurately reflect the hours worked at the time of injury for both cases and controls.

Characterizing the Work Shifts

Several categories of shifts worked prior to the injury incident were constructed, including consecutive work days, and cumulative hours worked in the previous 7 and 28 days and cumulative shifts worked in the previous 7 and 28 days. For each of these categories, several measures were created and were calculated for both the cases and the controls. For the consecutive workdays category, the first measure was the number of consecutive days for which a staff member worked a shift greater than 4 hours prior to the date of the occupational injury. The second measure was the number of consecutive days for which a staff member worked a shift greater than 12 hours. The final measure was the number consecutive days worked with night shifts greater than 12 hours. For the previous 7 days and 28 day categories, two types of measures were used - cumulative counts of shifts and cumulative hours worked were calculated. Cumulative counts included 4 measures: number of shifts greater than 4 hours, number of shifts greater than 12 hours, number of night shifts greater than 4 hours and number of night shifts greater than 12 hours. Cumulative hours included two measures, total number of hours work and total number of hours worked in a night shift. A shift was categorized as a night shift if it included 1:00 am and 2:00 am as part of the shift.

Analysis

After comparing the characteristics for cases and controls, conditional logistic regression was employed to calculate incidence odds ratios with 95% confidence intervals for cumulative hours and days. Prior to calculating the odds ratios, consecutive days, cumulative days for 7 and 28 days and cumulative hours for 7 and 28 days were categorized into groups by increasing exposure, with normal shift lengths used as a guide to forming the categories. A referent group of no or low exposure was used to compare all exposure groups for consecutive days, cumulative days and hours in this dataset. FTEs were compared to shifts worked and added to all models. All analyses were performed using the personal computer version of STATA 11.1 SE from Statacorp, College Station, Texas.

Results

A total of 502 injuries out of the 533 injuries for calendar year 2008 were eligible for the study and successfully matched to a control staff member in the cohort (Table 1). Approximately half the injuries are OHSA recordable with either medical treatment, lost days or restricted days recorded. Cases and controls were matched on all characteristics in Table 1 except scheduled hours per week and OSHA recordable injury, which did not exist for the controls. The cases and controls were similar in mean age. However cases and controls did not have similar FTEs with median hours worked being 36 for cases and 32 for controls. The 31 injured workers not matched were compared to those matched in the analysis and found to be similar overall. As expected, the majority of injuries were found among employees on adult medical/surgical floors, where the greatest number of health care workers care found in the hospital setting.

Consecutive shifts were categorized by any type of consecutive shift worked, followed by 12-hour or more consecutive work shifts and finally 12- hour or more consecutive nightshifts. Injury incident ORs were higher for consecutive work shifts, with the exception of working one or two shifts of any length prior to injury for which the OR was 0.81 (CI: 0.60–1.08 when compared to working no previous shifts (Table 2). For consecutive days, only working 1–2 days of 12-hours shifts prior to injury was significant with an injury incident OR of 1.77 (CI: 1.30–2.44) when compared to no shifts worked prior to injury.

Injury incident ORs increased with more cumulative shifts and cumulative hours worked in the previous 7 days (Table 3). Shifts were again categorized: total shifts worked, total night shifts, total shifts 12 or more hours and total night shifts of 12 or more hours. Total hours worked the previous 7 days included total hours worked and total night hours worked. Cumulative shifts were significant for 3 or more night shifts (OR = 2.90; 95% CI = 1.47–5.74) and three or more 12-hour night shifts (OR = 2.09; 95% CI = 1.10–4.98) compared to no shifts in the previous 7 days. Cumulative hours worked for 7 days prior to injury were significant for 29 to 36 hours (OR = 1.68; 95% CI = 1.20–2.36) and working greater than 36 hours(OR = 1.26; 95% CI = 1.02–1.54) compared to working less than 20 hours. Additionally, injury rates among staff working greater than 36 night hours (OR = 1.34; 95% CI = 1.07–1.66 were statistically significant when compared to working less than 20 night hours in the previous 7 days.

For the previous 28 days (4 weeks), the injury incident ORs increased with more cumulative shifts and the cumulative hours worked (Table 4). To characterize the cumulative hours worked during the 28 day period, the hours were similar to those worked in seven days but multiplied by 4 for comparison. For example, a work period of less than 80 hours for 4 weeks was equivalent to 4 weeks of less than 20 hours worked per week. For a 28 day period, the injury incident ORs were 2.09 (95% CI = 1.12–3.89) for 12 or more shifts of any length when compared to 6 shifts of any length. The ORs for night shift were 2.18 (95% CI = 1.26–3.78) for 6 to 12 total night shifts of any length and 2.24 (95% CI = 1.05–4.76) for 12 or more 12-hour night shifts compared to less than 6 night shifts in a month. Cumulative hours for a 28 day period was significant for 116–144 hours (OR = 1.76; 95% CI = 1.13–2.74) and working greater than 144 hours (OR = 1.53; 95% CI = 1.07–2.17) compared to working less than 80 hours in 28 days. Additionally, injury rates among staff working greater than 144 night hours (OR = 1.50; 95% CI = 1.06–2.14) were statistically sifnificant when compared to working less than 80 night hours in 28 days.

Discussion

The purpose of this study is to examine staff work patterns preceding an injury and compare these to gender- and age-matched controls using hospital administrative injury and work history data. For almost all of the measures of consecutive and cumulative work metrics, the researchers observed a trend of increasing ORs with increasing number of consecutive work days and cumulative work shifts and hours. A few of the odds ratios in all categories of consecutive shifts, cumulative shifts and cumulative hours were either statistical significant or indicated strong associations.

The researchers found that consecutive days or working more shifts in a row, with the exception of one or two shifts of any type prior to injury showed moderate increases in ORs for occupational injury. Whereas many of these consecutive shifts findings were not statistically significant with the exception of one or two 12-hour shifts prior to injury, they may be due to inadequate power, low number of staff working three or more shifts or to the addition of 4- to 8-hour shifts in the study limiting worker exposure (i.e., the use of short 4-hour shifts may have impacted the results). In general, prior to this study, the impact of consecutive shifts on injury rates had not been adequately explored in the literature, most likely due to the specificity of administrative data needed to explore the phenomenon of consecutive days.

This study also revealed that increasing the number of shifts and hours worked during a 1- or 4-week period is associated with increasing ORs when compared to workers that work part time shifts. The researchers found that increasing the total number of cumulative days and hours worked in a week or month is associated with increased an odds of injuries among hospital direct care providers (i.e., the more workers work, the more they may become injured). This is not a surprising finding, but has only been explored regarding overtime or extended shifts in the literature citing occupational injury related to these longer time periods (Bendak, 2003; Caruso, 2006; Dembe et al., 2009; Grosch, Caruso, Rosa, & Sauter, 2006; Ilhan, Durukan, Aras, Turkcuoglu, & Aygun, 2006; Johnson & Lipscomb, 2006; Trinkoff et al., 2006). One reason for the lack of correlation between shift types and injury rates may also be related to the definition of shifts, in addition to specificity in some databases regarding shift length (Caruso et al., 2006; Caruso & Waters, 2008; Driscoll, Grunstein, & Rogers, 2007).

The relationship of cumulative shifts to injury was stronger for when combined with 12 hour shifts. The 12-hour shifts are may be an attractive shift choice because they allow workers to request stretches of workdays followed by several days off to accommodate schedules outside work but may be a concern for occupational injury. Although the extended shifts, followed by extended rests, may be desirable, the overall impact may be increased occupational injuries associated with these longer shifts (Bendak, 2003; Dwyer, Jamieson, Moxham, Austen, & Smith, 2007).

An increase in OR for occupational injuries was found with consecutive shifts and cumulative shifts when they were combined with nightshifts. Working night shifts and rotating to night shifts has also been associated with increased injury rates (Caruso & Condon, 2006; Dembe et al., 2009; Muecke, 2005).

Many studies have explored shifts and work characteristics such as job satisfaction, errors or health. Several investigators have explored the relationship between 12-hours shifts and job performance (Fitzpatrick, While, & Roberts, 1999), job satisfaction and turnover (Bame, 1993; Coffey, Skipper, Jr., & Jung, 1988; Ruggiero & Pezzino, 2006). Night shifts were associated with loss of sleep (Burch et al., 2009; Novak & Auvil-Novak, 1996), and patient errors (Ohayon, Lemoine, Arnaud-Briant, & Dreyfus, 2002). Additionally, overall health and wellbeing were examined with respect to various shifts (Barnes-Farrell et al., 2008; Conway, Campanini, Sartori, Dotti, & Costa, 2008; DeMoss, McGrail, Jr., Haus, Crain, & Asche, 2004; Poissonnet & Veron, 2000). Although many of these studies do not implicate various shifts as a cause of occupational injury, the range of studies illustrates the complexity of evaluating shift work among health care workers.

The main strength of this study is the large number of participants in this cohort, allowing for detection of differences in staffing patterns and injuries. This study is generalizable to large academic hospital in the northeast. Another strength of this study is the use of detailed and accurate payroll data used analysis. Individual staffing schedules were amended at these two institutions because hours from the scheduling system were directly exported to the payroll system. The accuracy of this data allowed detailed analysis of cumulative days and cumulative shifts and hours.

Limitations were also found in working with large datasets. Misclassification of data is always a concern due to inaccurate or missing data entering. However, missing data does not appear to be a problem as less than 3% of the variables had any missing data. Additionally, misclassification of unit or incorrect ledgers of staff schedules can bias toward the null hypothesis and no difference in injury rate would be seen. The researchers were also not able to account for shifts that may be worked at another area of the hospital outside Patient Care Services or at another institution. The detailed staffing data available at each institution minimized misclassification of the data and minimized missing data from other departments or institutions by setting inclusion criteria to include workers that worked substantial hours at their respective institution. Several concerns were identified when working with reported injury data. It is unclear if incident reporting is accurate and if they reflect true injury rates because many incentives and disincentives exist for employees to report injuries. Therefore, care should be taken when interpreting incident report data. However, variability in reporting injuries appears random and it does not appear that underreporting or overreporting of injuries significantly impacted the overall number of work-related injuries in these units.

Finally, one major disadvantage of case-control studies is that they do not indicate absolute risk, rather the risk of the category worked related to another lower or referent category. However, understanding the relative risks of various categories of work can also provide valuable information.

Implications for Occupational Health Nurses

Occupational health nurses must be aware of the type and length of shifts employees work at the various work sites they oversee. Shift characteristics (e.g., length, consecutive days worked, total hours worked, night shifts, and overtime) are an important component of working conditions, and some shift characteristics may contribute to employee injuries. When little information on employee shifts exists, routine detailed assessment of shift information for individual workers can be valuable, with emphasis on how shift characteristics may contribute to workplace illness and injury.

Workplace policy development related to shifts can also make an important contribution to the health and safety of workers. The assessment of existing work site policies and the level of specificity may be crucial to occupational health nurses' understanding characteristics of work shift scheduling of employees. Occupational health nurses should assess, wen possible, whether policies address details such as minimum number of days or weeks on a specific shift, how sifts rotate, number of days that can be worked consecutively without a day off, the maximum length of a shift, or the amount of overtime in a given shift or week. Such information is valuable for understanding how much latitude is given in the scheduling process and the potential variance that might be seen in shift schedules. Some managers and schedulers may follow the policies as written, whereas others may adjust the policies for their particular area. Understanding how shifts are assigned may offer valuable insight into the scheduling culture of the work site and allow the occupational health nurse to advocate for detailed work shift policies and adherence to those policies.

Conclusion

Understanding organizational scheduling patterns and their impact on occupational injuries is essential when exploring how work shift patterns can be altered to decrease injuries to direct patient care providers. The researchers have observed increased risk of injury with consecutive work days and longer cumulative working hours. Future research in this area should be conducted to overcome limitations more reliably examine the impact of consecutive working shifts.

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Applying Research to Practice (Sidebar)

In general, a trend was found toward increased odds of injury as the number of cumulative work shifts and hours in the previous week or month increased, especially with 12-hour shifts. Consecutive workdays, a recent trend in health care, are also associated with increased odds of injury. Future research examining the impact of consecutive shifts on injuries is recommended.

Table 1

Select characteristics of units and direct care provider cases and controls.

	Cases n = 502	Controls n =502
Hospital 1	235	235
Hospital 2	267	267
Age (median)	40 (38–42)	39 (37–41)
Gender		
Female 5.8%(4.3–7.2)	473 (92.4%)	473
Male 94.2%(92.7–95.7)	29 (5.8%)	29
Scheduled hours per week(median)	36 (36–36)	32 (28–36)
Job Type		
RN 84.1% (81.8–86.3)	422 (84.1%)	422
PCA 15.9% (13.7–18.2)	80 (15.9%)	80
OSHA recordable injuries	223	
Unit Type		
Adult Med Surg Units	257	257
Adult ICU	92	92
Stepdown	65	65
Pediatric Units	21	21
OB-Postpartum	67	67

Note: RN = Registered Nurse; PCA = Patient Care Associate; OSHA = Occupational Safety and Health Administration; ICU = Intensive Care Unit; OB = Obstetrics

Table 2

Odds ratios for consecutive shifts (number of shifts worked in a row) prior to the injury.

Exposure-Consecutive shifts worked in a row	Number of shifts	Cases N=502	Controls N=502	OR (95% CI)	p-value
Any shifts ≥ 4 hours (days, evenings, nights or rotating)	0	299 (59.6%)	306 (61.0%)	1*	
	1–2	190 (37.8%)	190 (37.8%)	0.81 (0.60–1.08)	0.16
	3–11	13 (2.6%)	6 (1.2%)	1.19 (0.39–3.65)	0.75
12-hr(or longer) shifts (days, evenings, nights or rotating)	0	297 (59.2%)	373 (74.3%)	1*	
	1–2	189 (37.6%)	124 (24.7%)	1.77 (1.30–2.44)	0.000
	3–6	16 (3.2%)	5 (1.0%)	1.30 (0.70–2.43)	0.402
12-hr (or longer) night shifts	0	336 (72.1%)	362 (77.7%)	1*	
	1–2	115 (24.7%)	91 (19.5%)	1.09 (0.76–1.57)	0.64
	3–6	15 (3.2%)	13 (2.8%)	1.19 (0.71–2.01)	0.50

Note. OR = Odds Ratio; CI = confidence interval

*Referent category

Table 3

Odds ratios for number of shifts or hours worked 7 days prior to the day of the injury.

Exposure-All shifts and hours worked in previous 7 days	Number of shifts	Cases N=502	Controls N=502	OR (95% CI)	p-value
Total shifts (any shift ≥ 4 hours) in previous 7 days	0	17 (3.4%)	40 (8.0%)	1*	
	1–2	304 (60.6%)	354 (70.5%)	1.75 (0.82–3.71)	0.15
	3–6	181 (36.1%)	108 (21.5%)	1.68 (0.94–2.99)	0.08
Total 12-hr (or longer) shifts in previous 7 days	0	114 (22.7%)	137 (27.3%)	1*	
	1–2	341 (67.9%)	338 (67.3%)	1.09 (0.77–1.54)	0.062
	3–6	47 (9.4%)	27 (5.4%)	1.00 (0.57–1.76)	0.99
	Hours worked				
Total hours worked in previous 7 days	<20	97 (19.3%)	189 (37.7%)	1*	
	20–28	124 (24.7%)	125 (24.9%)	1.44 (0.81–2.55)	0.21
	29–36	127 (25.3%)	98 (19.5%)	1.68 (1.20–2.36)	0.002
	>36	154 (30.7%)	90 (17.9%)	1.26 (1.02–1.54)	0.028
Exposure-Night shifts and hours in previous 7 days	**Number of shifts**	**Cases N=466**	**Controls N=466**	**OR (95% CI)**	**p-value**
Total night shifts (length ≥ 4 hours) in previous 7 days	0	29 (6.2%)	59 (12.7%)	1*	
	1–2	271 (58.2%)	315 (67.6%)	1.26 (0.69–2.30)	0.45
	3–6	166 (35.6%)	92 (19.7%)	2.90 (1.47–5.74)	0.002
Total 12-hr (or longer) night shifts in previous 7 days	0	111 (23.8%)	151 (32.4%)	1*	
	1–2	312 (67.0%)	291 (62.4%)	1.31 (0.75–1.48)	0.76
	3–6	43 (9.2%)	24 (5.2%)	2.09 (1.10–4.98)	0.028
	Hours worked				
Total night hours worked in previous 7 days	<20	100 (21.5%)	175 (37.6%)	1*	
	20–28	97 (20.8%)	108 (23.2%)	0.89 (0.50–1.60)	0.705
	29–36	126 (27.0%)	104 (22.3%)	1.33 (0.98–1.81)	0.070
	>36	143 (30.7%)	79 (16.9%)	1.34 (1.07–1.66)	0.009

Note. OR = Odds Ratio; CI = confidence interval

*Referent category

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Table 4

Odds ratios for number of shifts or hours worked 28 days (4 weeks) prior to the day of the injury.

Exposure-Count of days worked in previous 28 days (4 weeks)	**Number of shifts**	**Cases N=448**	**Controls N=448**	**OR (95% CI)**	**p-value**
Total shifts (any shift ≥ 4 hours) in previous 28 days	<6	27 (6.0%)	89 (19.9%)	1*	
	6–12	252 (56.3%)	258 (57.6%)	2.15 (1.23–3.75)	0.007
	>12	169 (37.7%)	101 (22.5%)	2.09 (1.12–3.89)	0.02
Total 12-hr (or longer) shifts in previous 28 days	<6	174 (38.8%)	248 (55.4%)	1*	
	6–12	246 (54.9%)	192 (42.9%)	1.31 (0.94–1.83)	0.11
	>12	28 (6.3%)	8 (1.8%)	2.09 (0.98–4.47)	0.06
Total night shifts (length ≥ 4 hours) in previous 28 days	<6	31 (6.9%)	93 (20.8%)	1*	
	6–12	254 (56.7%)	256 (57.1%)	2.18 (1.26–3.78)	0.006
	>12	163 (36.4%)	99 (22.1%)	1.62 (0.94–2.79)	0.085
Total 12-hr (or longer) night shifts in previous 28 days	<6	253 (56.5%)	180 (40.2%)	1*	
	6–12	187 (41.7%)	244 (54.5%)	1.25 (0.89–1.75)	0.20
	>12	8 (1.8%)	24 (5.4%)	2.24 (1.05–4.76)	0.036
Exposure-Hours worked in previous 28 days (4 weeks)	**Hours worked**	**Cases N=448**	**Controls N=448**	**OR (95% CI)**	**p-value**
Total hours worked in previous 28 days	<80	61 (13.6%)	146 (32.6%)	1*	
	80–115	126 (28.1%)	149 (33.3%)	1.41 (0.82–2.44)	0.22
	116–144	114 (25.4%)	71 (15.8%)	1.76 (1.13–2.74)	0.013
	>144	147 (32.8%)	82 (18.3%)	1.53 (1.07–2.17)	0.019
Total night hours worked in previous 28 days	<80	68 (15.2%)	150 (33.5%)	1*	
	80–115	127 (28.3%)	153 (34.2%)	1.46 (0.86–2.48)	0.17
	116–144	109 (24.3%)	72 (16.1%)	1.45 (0.96–2.19)	0.08
	>144	144 (32.1%)	73 (16.3%)	1.50 (1.06–2.14)	0.023

Note. OR = Odds Ratio; CI = confidence interval

* Referent category