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Obstructive sleep apnoea and frequency of occupational injury

Abstract We sought to determine whether patients with obstructive sleep apnoea (OSA) are at increased risk of occupational injury (OI). Patients referred to the University of British Columbia Hospital Sleep Laboratory for suspected OSA (May 2003 to July 2011 were recruited and rates and types of validated OI (that caused at least 1 day of disability) in the 5 years prior to polysomnography were calculated. In a sample of 1236, patients with OSA were twice as likely (OR=1.93, 95% CI 1.06 to 3.50, p=0.03) to suffer at least one OI compared with patients without OSA. This association was attenuated (OR=1.76, CI 0.86 to 3.59, p=0.12) after controlling for confounders. In a secondary analysis, patients with OSA were almost three times more likely (OR=2.88, CI 1.02 to 8.08, p=0.05) to suffer from an injury more likely related to reduced vigilance (eg, a fall or commercial motor vehicle crash) when compared with patients without OSA, and this again was attenuated after controlling for confounders (OR=2.42, CI 0.085 to 6.93, p=0.10).

INTRODUCTION

Occupational injuries (OIs) are a major problem worldwide, resulting in an estimated 360 000 fatal injuries per year; additionally, more than 960 000 workers become injured daily because of OI.[1] Obstructive sleep apnoea (OSA) results in sleep fragmentation, decreased alertness and neurocognitive dysfunction.[2 3] We hypothesised that patients with OSA might have an increased risk of OI, particularly those injuries that might be related to reduced vigilance. To address this issue, we analysed a large cohort of patients using validated measures of OI and OSA.

METHODS

Consenting adult patients who reported working more than 10 h per week and were referred to the University of British Columbia Hospital Sleep Disorder Laboratory for polysomnography (PSG) for suspected OSA between January 2003 and July 2011 were eligible for recruitment. Patients were excluded if they were medically unstable, had a mental disability or had active psychiatric disease.

Inpatient PSG was performed using conventional instrumentation and scored according to standard recommendations.[4] Patients were dichotomised as 'yes' or 'no' for OSA, based on an apnea-hypopnea index (AHI) of $\geq$5/h.

OIs were identified from claims data from WorkSafeBC. WorkSafeBC is the sole provider of workers' compensation benefits in the province of British Columbia for almost all (93–94%) of the labour force. We only analysed claims that resulted in at least 1 day of absence from work, as these disability claims include data on the date and type of injury.[5]

On the night of PSG, patients were given a questionnaire that was completed in the sleep laboratory, and included information about medical history, type of industry defined as blue-collar (primary resources, manufacturing, construction or transportation and warehousing industries) or white-collar (eg, financial services or sales), and alcohol use (yes or no to consumption at least once per month). Subjective sleepiness was measured by the Epworth Sleepiness Scale (ESS). Body mass index (BMI) was calculated from height and weight measurements taken while patients were wearing light clothing.

Data analysis

The number of OIs in the 5 years prior to the PSG was determined for each patient. Since only a small portion of patients had multiple injuries, a binary definition for outcome (ie, any OI or no OI) was used. Logistic regression analysis was used to model the odds of OI between the OSA versus no OSA groups. The final model was adjusted for gender, BMI, alcohol use, age and industry group.

In a secondary analysis, the OI group was further divided into at least one vigilance related injury. These were injuries which were more likely to be related to reduced vigilance according to previous literature on mechanisms/causes of injury.[6 7] These vigilance related injuries included falls, contact with heat or electricity, motor vehicle crashes and injuries related to slipping/tripping. Given three levels of outcomes (ie, vigilance related injury, non-vigilance related injury and no injury), we used multinomial logistic regression to model the association between the odds of injury and OSA.

Statistical analyses were conducted using SAS V.9.2 (SAS Institute, Cary, North Carolina, USA).

RESULTS

There were a total of 1236 patients included in the analysis (tables 1 and 2). A total of 152 claims were reported; 59 (39%) were vigilance related and 93 (61%) were non-vigilance related. Of the 111 patients with OI, 49 patients (44%) had at least one vigilance related injury while 62 patients (56%) had non-vigilance related injuries. Almost 10% (9.9%) of patients with OSA had an OI compared with 5.4% of those without OSA (unadjusted odds 1.93 (CI 1.06 to 3.50, p=0.03)). This association was attenuated in the multivariable model (OR=1.76, CI 0.86 to 3.59, p=0.12).

Patients with OSA had an almost threefold increase in the odds of a vigilance related injury (OR=2.88, CI 1.02 to 8.08,

Table 1 Baseline characteristics of patients with and without OSA

	All (n=1236)	No OSA (n=242)	OSA (n=994)	p Value
Continuous variable*				
Age (years)	49 (40, 55)	44 (35, 53)	49 (42, 56)	<0.01
AHI	15 (7, 30)	2 (1, 4)	20 (12, 35)	<0.01
ESS	10 (6, 14)	11 (7, 14)	10 (6, 14)	0.86
Time worked per week (h)	40 (37, 50)	40 (37, 50)	40 (37, 50)	0.67
BMI	30 (27, 35)	28 (25, 33)	31 (27, 35)	<0.01
Mean claim cost	2139 (736, 6513)	1085 (404, 4622)	2159 (792, 6513)	0.21
Categorical variables				
Gender (female)	374 (30.3%)	93 (38.4%)	281 (28.3%)	<0.01
Alcohol (yes)	855 (69.2%)	182 (75.2%)	673 (67.8%)	0.03
Industry (blue-collar)	346 (28%)	61 (25.2%)	285 (28.7%)	0.28
Occupational injuries				
Patients with injuries	111 (8.98%)	13 (5.37%)	98 (9.86%)	0.03
Patients with vigilance related injuries	49 (3.96%)	4 (1.65%)	45 (4.53%)	0.04
Patients with non-vigilance related injuries	62 (5.02)	9 (3.72%)	53 (5.33%)	0.30

*Values presented for continuous variables correspond to the median and IQR.
AHI, apnea-hypopnea index; BMI, body mass index; ESS, Epworth sleepiness scale; OSA, obstructive sleep apnoea.

Table 2 Predictors of occupational injuries: results of logistic and multinomial logistic regressions

Model/variable	OR	95% CI	p Value
Primary analysis: any injuries			
Unadjusted OSA	1.93	(1.06 to 3.50)	0.03
Adjusted OSA	1.76	(0.86 to 3.59)	0.12
Gender	0.605	(0.32 to 1.15)	0.13
BMI	1.03	(0.99 to 1.06)	0.42
Alcohol use	0.80	(0.50 to 1.30)	0.37
Industry (blue-collar)	5.50	(3.39 to 8.75)	<0.01
Age	0.93	(0.97 to 1.02)	0.56
Secondary analysis: vigilance related injuries			
Unadjusted OSA	2.88	(1.02 to 8.08)	0.05
Adjusted OSA	2.42	(0.85 to 6.93)	0.10
Gender	0.80	(0.37 to 1.73)	0.57
BMI	1.04	(1.01 to 1.08)	0.02

BMI, body mass index; OSA, obstructive sleep apnoea.

p value=0.05) compared with patients without OSA. Again, this association was attenuated after adjusting for confounders (OR=2.42, CI 0.85 to 6.93, p=0.10).

There was no consistent relationship between OI and OSA severity (OI in 9.06% of patients with severe OSA, 10.94% with moderate OSA and 9.59% with mild OSA). Higher ESS scores were also not associated with OI (p=0.54 in the unadjusted model).

DISCUSSION

Our findings are consistent with previous research showing increased rates of OI in patients with OSA.[7–10] The stronger relationship with vigilance related injury adds further plausibility to our findings. Our study had many strengths. First, we used the gold standard for OSA diagnosis (PSG) rather than sleep related symptoms or limited ambulatory testing.[4] In addition, OIs were validated through a claims database rather than self-reports (which would be susceptible to recall bias). Finally, our sample size was relatively large.

However, there were a number of study limitations. First, risk of OI was assessed retrospectively from patients seen in a sleep disorders clinic, rather than from a population-based sample. This may introduce bias in that work performance or injury may have been a factor contributing to referral. Second, not all OIs are reported or captured by the workers' compensation system; however, if underreporting occurred, there is no evidence to suggest that this would have been differential by OSA status. Third, the ability to investigate the association between OSA and OI may have been diluted by a study sample that included patients referred to the clinic for non-respiratory sleep disorders (ie, insomnia, narcolepsy, depression). However, this is likely a minor concern since patients with predominately non-respiratory complaints are usually referred to psychiatrists associated with our sleep disorder clinic. Finally, several potentially confounding variables were not included in the analysis either because the data was not reliable or available; these included information about shift working, and sedative medications.

Patients with OSA are more likely to suffer an OI in the 5 years prior to PSG, and the impact may be greater for vigilance related injuries. Future research should focus on identifying a high-risk group of workers who might benefit from screening, diagnostic testing and consequent treatment for OSA.

Key messages

What is the key question?

- Do patients with obstructive sleep apnoea (OSA) suffer more occupational injuries (OIs) than controls?

What is the bottom line?

- Patients with OSA are more likely to suffer an OI in the 5 years prior to polysomnography, and the impact may be greater for vigilance related injuries.

Why read on?

- This study uses a large sample size and both objective measures for predictor and outcome variables to demonstrate the magnitude of the additional risk borne by patients with OSA.

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REFERENCES

1 Hämäläinen P, Leena Saarela K, Takala J. Global trend according to estimated number of occupational accidents and fatal work-related diseases at region and country level. *J Saf Res* 2009;40:125e39.
2 Gurubhagavatula I. Consequences of obstructive sleep apnoea. *Indian J Med Res* 2010;131:188–95.
3 Guglielmi O, Jurado-Gámez B, Gude F, *et al*. Occupational health of patients with obstructive sleep apnea syndrome: a systematic review. *Sleep Breath* 2015;19:35–44. .
4 Berry RB, Budhiraja R, Gottlieb DJ, *et al*. Rules for scoring respiratory events in sleep: update of the 2007 AASM manual for the scoring of sleep andassociated events. Deliberations of the Sleep Apnea Definitions Task Forceof the American

Academy of Sleep Medicine. *J Clin Sleep Med* 2012;8:597–619.
5 WorkSafeBC[creator]. WorkSafeBC Claims and Firm Level Files. Population Data BC[publisher]. Linked Dataset. WorkSafeBC. 2013. http://www.popdata.bc.ca/data
6 Kling RN, McLeod CB, Koehoorn M. Sleep Problems and Workplace Injuries in Canada. *Sleep* 2010;33:611–18.
7 Lindberg E, Carter N, Gislason T, *et al*. Role of snoring and daytimesleepiness in occupational accidents. *Am J RespirCrit Care Med* 2001;164:2031–5.
8 Uehli K, Mehta AJ, Miedinger D, *et al*. Sleep problems and work injuries:a systematic review and meta analysis. *Sleep Med Rev* 2014;18:61–73.
9 Ulfberg J, Carter N, Edling C. Sleep-disordered breathing and occupational accidents. *Scand J Work Environ Health* 2000;26:237–42.
10 Accattoli MP, Muzi G, dell'Omo M, *et al*. Occupational accidents, work performance and obstructive sleep apnea syndrome (OSAS). *G Ital Med LavErgon* 2008;30:297–303.