

Title: **Short rest between shifts (quick returns) and night work are associated with work related accidents**

Running title: **Quick returns and work-related accidents**

Øystein Vedaa, PhD^{1,2,3}; Anette Harris, PhD⁴; Eilin K. Erevik, PhD⁴; Siri Waage, PhD^{5,6}; Bjørn Bjorvatn, PhD^{5,6}; Børge Sivertsen, PhD^{1,2,7}; Bente E. Moen, PhD⁵; Ståle Pallesen, PhD^{4,6}

¹ Department of Mental Health, Norwegian University of Science and Technology, Trondheim, Norway;

² Department of Health Promotion, Norwegian Institute of Public Health, Bergen, Norway;

³ St. Olavs University Hospital, Division of Mental Health Care, Department of Østmarka, Trondheim, Norway;

⁴ Department of Psychosocial Science, University of Bergen, Bergen, Norway;

⁵ Department of Global Public Health and Primary Care, Centre for International Health, University of Bergen, Bergen, Norway;

⁶ Norwegian Competence Center for Sleep Disorders, Haukeland University Hospital, Bergen, Norway;

⁷ Department of Research & Innovation, Helse Fonna HF, Haugesund, Norway

Correspondence to: Øystein Vedaa Ph.D., Department of Health Promotion, Norwegian Institute of Public Health, Zander Kaaes gate 7, 5018 Bergen, Norway; e-mail: oystein.vedaa@ntnu.no.

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Abstract

Purpose: The aim of this study was to examine whether less than 11 hours between shifts (i.e. quick returns, QRs) and night shifts are associated with self-reported work-related accidents, near accidents or dozing off at work in a sample of nurses.

Methods: The study was based on cross-sectional data from 1,784 nurses (response rate=60%; mean age=40.1 yrs., SD=8.4; 91% female). Negative binomial regression analyses were conducted to investigate the association between the shift exposures, and eight different self-reported work-related items on accidents, near accidents and dozing off at work, controlling for demographics and work factors.

Results: The number of QRs during a year was positively associated with seven of the eight items on work-related accidents, near-accidents and dozing off at work, and number of night shifts was positively associated with five items. Some of the key findings were that QRs were associated with nurses causing harm to themselves (incidence rate ratio [IRR] = 1.009; 95%CI = 1.005-1.013), causing harm to patients/others (IRR = 1.006; 95%CI = 1.002-1.010) and causing harm to equipment (IRR = 1.004; 95%CI = 1.001-1.007); while night shifts were associated with nurses involuntarily dozing off at work (IRR = 1.015; 95%CI = 1.013-1.018), dozing off while driving to/from work (IRR = 1.009; 95%CI = 1.006-1.011), and harming patients/others (IRR = 1.005; 95%CI = 1.001-1.009).

Conclusion: QRs and night shifts were both associated with the self-reported work-related accidents, near-accidents and dozing off at work. Studies that can establish the causal relationship between QRs and accidents are called for.

Key words: Quick returns, Night shifts, Accidents, Injury, Near accidents, Dozing off

Introduction

An important principle in the design of shift work schedules is that workers are allowed sufficient time to rest and recuperate between shifts. This is for example emphasized in the EU's Working Time Directive (2003/88 / EC), where workers are entitled to a minimum daily rest period of 11 consecutive hours per 24 hour. However, through local agreements between the employer and the employee representatives in certain countries, several exemptions from this rule have been agreed upon. Consequently, less than 11 hours of rest between shifts are common among some occupational groups and this is referred to as quick returns (QRs). In the sixth European working conditions survey, 23% of employees in European countries reported having at least one QR the last month (European Foundation for the Improvement of Living and Working Conditions 2016). In the Norwegian Survey of Shiftwork, Sleep and Health among nurses (SUSSH), 81% of the nurses reported having QRs in their schedule, with a mean of 33 QRs per year (Eldevik et al. 2013). Most QRs occur in rotating shift work when an evening shift is followed by a day shift, which for Norwegian nurses may leave no more than nine hours off between two shifts (Vedaa et al. 2017b). QRs may be a particularly detrimental feature of rotating shift work, as several recent studies have reported more negative consequences of QRs than of night shifts on outcomes such as sleep duration, sleep quality, fatigue, and sick leave rates (Dahlgren et al. 2016; Flo et al. 2014; Vedaa et al. 2017a; Vedaa et al. 2017b). One study showed that levels of sleepiness at day work after QRs from evening to day shifts was equal to that reported during the second night of two consecutive night shifts (Vedaa et al. 2017a).

Sleepiness and fatigue are well-known risk factors for impaired performance, accidents and injuries (Robb et al. 2008; Williamson et al. 2011; Zhang and Chan 2014; Åkerstedt 1995). Impaired alertness is evident when working during the night, especially when working close to the circadian nadir for core body temperature, leading to increased risk of accidents

(Åkerstedt et al. 2001). Extended periods of wakefulness also increase the risk of accidents, as in the case of long working hours (>8h) (Folkard and Tucker 2003; Kunaviktikul et al. 2015) and with night shifts following poor daytime sleep (Åkerstedt 1995). A special concern is the risk of car accidents during commutes to and from work, especially when driving home after a night shift (Dorrian et al. 2008; Zhang and Chan 2014). It is well documented that QRs are associated with curtailed sleep (Vedaa et al. 2016), which again may increase the risk of accidents. In one recently published study that used payroll data from more than 60,000 employees to assess exposure to QRs, and national records of injuries as an outcome measure, found that a QR was associated with a 39% higher risk of injury compared to having 15-17 hours off between shifts (Nielsen et al. 2018). A longitudinal survey found evidence to suggest an increased risk of needlestick injury for nurses who reported having a work schedule that included <10 hours off between shifts (Trinkoff et al. 2007). Still, very few studies have investigated the association between QRs and work-related accidents.

The purpose of the present study was therefore to build on this limited research and expand our knowledge concerning the relationship between QRs and self-reported work-related accidents, near accidents or dozing off at work in a cross-sectional survey in a large sample of nurses. A secondary aim was to examine the association between night shifts and self-reported work-related accidents, near accidents or dozing off at work. We hypothesized that QRs and night shifts would be associated with more self-reported work-related accidents, near accidents or dozing off at work.

METHODS

Subjects and procedure

The present study was based on data from the Norwegian Survey of Shiftwork, Sleep and Health among nurses (SUSSH). The SUSSH was established in 2008/2009, where

surveys are carried out annually. Registered members of the Norwegian Nurses Organisation were recruited to participate (N = 6,000). The invited nurses were randomly selected from five different strata based on the number of years since they completed their bachelor's degree and qualified as a nurse. Specifically, 1,200 nurses from the following five strata were invited: 0-1.0 years since completing the degree, 1.1-3.0 years, 3.1-6.0 years, 6.1-9.0 years and 9.1-12.0 years. A total of 600 invitations came in return due to wrong addresses. Finally, 2,059 nurses responded yielding a response rate of 38% (2059/5400). In 2009, 2,741 newly graduated nurses were invited to participate, of which 905 agreed, amounting to a response rate of 33%. These two groups together formed the baseline cohort of the SUSSH. The present study is based on cross-sectional data from the 2016 survey (wave 8). Background information, in terms of sex and year of birth was gathered from the 2008/2009 survey (wave 1). Data collection for wave 8 took place during the spring/summer of 2016 and a total of 1,784 completed the survey. This comprised 60% of those who originally agreed to participate.

The survey was sent to each nurse's home address by letter, together with a prepaid return envelope. Up to two reminders were sent to those who did not respond. Twenty-five randomly selected participants from each wave received a gift card of 500 NOK (~ 53 Euro/62 USD). Participation was voluntary, and the study protocol was approved by the Regional Committee for Medical Research Ethics in Western Norway (No. 088.88) as well as by the Norwegian Data Inspectorate (08/01235/IUR).

Measures

Demographics and work. Demographic characteristics included information about the participants' sex, age, relationship status (living alone or with a partner) and having at least one child in the household (yes/no). Number of QRs and number of night shifts worked the

last year were measured with open-ended questions: “Over the past 12 months, how many times have you had less than 11 hours free between two shifts? (approximate number)” and “How many night shifts have you worked in the last 12 months? (approximate number)”. The question concerning percentage of full time equivalent (FTE) had four response categories (<50%, 50-75%, 76-90% and >90%).

Work-related negative incidents. Eight items assessing the number of self-reported work-related accidents, near accidents and dozing off at work were constructed for the purpose of the study (Andreassen et al. 2018). The questions were phrased as follows: 1) How many times during the last month have you dozed off involuntarily at work? How many times during the last year have you: 2) Dozed off while driving to or from work? 3) experienced work-related accidents that you felt responsible for, causing harm to yourself? 4) experienced work-related near-accidents you felt responsible for, potentially causing harm to yourself? 5) experienced work-related accidents you felt responsible for, causing harm to patients/others? 6) experienced work-related near-accidents you felt responsible for, potentially causing harm to patients/others? 7) experienced work-related accidents you felt responsible for, causing harm to equipment? and 8) experienced near-accidents you felt responsible for, potentially causing harm to equipment? In this study, these eight items were used as dependent variables in eight separate analyses.

Statistical analyses

Statistical analyses were performed in IBM SPSS Statistics, version 25 for Macintosh. We performed descriptive analyses of each study variable and calculated the results in terms of means and standard deviations or as percentages. The dependent variables were self-reported work-related accidents/near-accidents or dozing off at work, which generally were rare events where the mean was close to 0. Such skewed distributions in the dependent

variables require the use of generalized linear model (GLM) Poisson or negative binomial regression. The latter had the best model fit for all analyses and was therefore used to investigate the association between number of QRs and number of night shifts during the last year on the eight different work-related accidents/near-accidents. Crude models were performed, as well as models adjusting for sex, age, relationship status, having children in the household, percentage of FTE, and shift exposure (QRs and night shifts). The rationale for including this list of confounders was that they define some of the basic elements of an individual's life situation and have all been found to account for part of the variance of work-related accidents/near-accidents in previous research (Andreassen et al. 2018; Benavides et al. 2006; DeLeire and Levy 2004; DMV.org). Four participants reported having 365 QRs or more during the past year, and these were deemed erroneous and replaced by missing values. The default output of negative binomial analyses are log counts, which were converted into incidence rate ratios (IRR) and reported as such in the present study. Percentage of FTE was dummy coded, so that >90% comprised the reference category. An alpha level of .05 was set to indicate statistical significance. Missing values were treated as invalid in the analyses (CLASSMISSING=EXCLUDE).

RESULTS

Descriptive analyses

Table 1 provides an overview of demographics and sample characteristics. The proportion of nurses who reported having at least one QR and one night shift during the past year were 38% and 27%, respectively. The descriptive statistics for each of the items on work-related accidents/near-accidents/dozing off at work are provided in Table 2. The percentage of participants reporting one or more accident/near-accident/dozing off at work the last month/year ranged from 6% ("Caused harm to patients/others the past year") to 26%

(“Dozed off involuntarily at work the past month”). Analyzing the eight accident/near-accident/dozing off at work items combined, 47% of the participants reported at least one of these incidents the last month/year.

QRs and work-related accidents

The results from the crude and fully adjusted negative binomial analyses of the association between shift exposures and eight self-reported accident/near-accident outcomes are presented in Table 3. The crude model showed that the number of QRs during a year was associated with an increase in all eight items on accidents/near-accidents/dozing off at work. In the fully adjusted model, number of QRs during a year was associated with more incidents of all but one (dozing off while driving to/from work) of the work-related accidents/near-accidents (dozing off at work, causing harm to oneself, nearly causing harm to oneself, causing harm to patients/others, nearly causing harm to patients/others, causing harm to equipment, and nearly causing harm to equipment). For example, the results from the fully adjusted model showed that for every one-unit increase in QRs (i.e. increase in one QR), the expected log count for nurses harming themselves was 0.009 (IRR=1.009). We can calculate the expected IRR with the mean number of QRs by multiplying the log count with the mean number of QRs. In doing so, the results from the fully adjusted model show that having 28 QRs during a year was associated with 29% more incidents of nurses harming oneself during that year, compared to having no QRs. Using the same procedure, the results show that having 28 QRs during a year was associated with 12% more incidents of dozing off at work the last month, 18% more incidents of causing harm to patients/others and 29% more incidents of causing harm to equipment during that year, compared to those with no QRs.

Night shift and work-related accidents

In the crude model, number of night shifts the last year was associated with three of the eight accident/near-accident/dozing off at work outcomes; and in the fully adjusted model, number of night shifts was associated with five of the eight accident/near-accident/dozing off at work outcomes (Table 3). For example, the results from the fully adjusted model showed that for every one-unit increase in night shifts, the expected log count for nurses involuntarily dozing off at work was 0.015 (IRR=1.015). The expected IRR with the mean number of night shifts (19.6 night shifts) amounts to 1.342, which suggests having 19.6 night shifts during a year was associated with 34% more incidents of involuntarily dosing off at work the last month, compared to those who had no night shifts. Similarly, based on the results from the fully adjusted model, having 19.6 night shifts during a year was associated with 19% more incidents of dozing off while driving to/from work that year, and 10% more incidents of causing harm to patients/others compared to those who had no night shifts. Number of night shifts the last year was unrelated to nurses causing harm to oneself and harming equipment during the year.

DISCUSSION

In this survey among nurses, we investigated whether QRs and night shifts were associated with self-reported work-related accidents, near accidents or dozing off at work. When adjusting for demographics and work factors, we found that number of QRs during one year was associated with seven of the eight items on work-related incidents investigated, including more incidents of dozing off at work, causing harm to oneself, causing harm to patients/others, and causing harm to equipment. Number of night shifts during one year was associated with five of the work-related incidents, including more incidents of dozing off at work, dozing off while driving to/from work, causing harm to patients/others and nearly causing harm to equipment.

The present study had a cross-sectional design that precludes inferences about causality. However, assuming that QR is a causal agent in the association with work-related incidents, the primary mechanisms for this would likely be the short sleep duration and elevated levels of sleepiness found to be associated with QRs (Vedaa et al. 2016). Studies on nurses have indicated that sleep duration is reduced to less than six hours with QRs from evening to day shifts (i.e. the most common type of QR) (Vedaa et al. 2017a). This is two hours shorter sleep duration compared to the sleep duration found between two consecutive evening shifts (Vedaa et al. 2017a). Previous studies have shown that obtaining less than six hours of sleep can have negative consequences that include deficits in cognitive functioning such as more impulsive actions (Demos et al. 2016), reduced sustained attention and working memory (Van Dongen et al. 2003), and concomitant elevated risk of accidents (Connor et al. 2002). Increased levels of sleepiness can cause recurrent intrusions of attentional lapses and microsleep periods, which contribute strongly to work-related injuries and accidents (Dinges 1995). It has also been pointed out that QRs from evening to day shifts give rise to high levels of sleepiness that progress during the busy day shift, which may be particularly problematic since the base rate opportunity for errors may be higher during the day shift, than for example during the night shift (Vedaa et al. 2017a).

A finding that raises particular concern is that QRs were associated with increased risk of nurses harming themselves and patients/others. The nurses had a mean number of 28 QRs the past year, which based on our results, was calculated to correspond to 29% more incidents of nurses harming themselves and 18% more incidents of causing harm to patients/others during that year, compared to those with no QRs. The increased incidence of nurses harming themselves is in line with two previous studies linking QRs to needle-stick injuries and other accidents/injuries (Macdonald et al. 1997; Nielsen et al. 2018; Trinkoff et al. 2007). The association between QRs and increased incidents of nurses harming patients/others is also a

highly relevant finding. In a recent Norwegian case record review study, it was concluded that 4.2% of 1,000 evaluated hospital deaths were ‘probably avoidable’ (Rogne et al. 2018). The researchers in that study made no direct attempts to delineate the role of inconvenient work hours in hospital deaths. However, other previous research has shown that patients who are admitted to hospitals at night or weekends have worse outcomes than those admitted at other times, where suboptimal levels of alertness and vigilance among the healthcare workers are at least part of the explanation (de Cordova et al. 2016; Silbergleit et al. 2006; Sorita et al. 2014). These studies nevertheless allude more to the negative effects of night shift work, as night shifts have traditionally been researched more than QRs.

Number of night shifts were also associated with nurses harming patients/others, although to a lesser degree than with QRs. Overall, the number of accidents/near-accidents were fewer related to night shifts than with QRs, with the exception of incidents of involuntarily dozing off at work and while driving to/from work, where the associated risk was higher with night shifts. Increased risk of accidents/near-accidents with night shifts were expected based on previous studies (de Cordova et al. 2016; Dorrian et al. 2008; Silbergleit et al. 2006; Sorita et al. 2014; Zhang and Chan 2014) and the primary mechanisms for this are believed to be elevated levels of sleepiness and the physiological deactivation that occur around the circadian nadir of the workers biological night (Åkerstedt 1995). It should be noted that in-patients usually do not require the same level of care during nights compared to the rest of the day (Nicoletti et al. 2014). This may help explain why the associated risk of accidents/near-accidents were lower with night shift than with QRs in the current study. Involuntarily dozing off at work may be dangerous for obvious reasons, although it did not seem to manifest in night shift workers harming themselves or equipment in this study. A silver lining of dozing off at work may be subsequent improvements in alertness and

performance that can protect against accidents (Richter et al. 2016). However, the uncontrolled nature of the doze reported in this study still makes it a potential safety hazard.

The results of the present study, as well as the results of several previous studies (Dahlgren et al. 2016; Flo et al. 2014; Vedaa et al. 2017a; Vedaa et al. 2017b), generally give the impression that there are more adverse effects of QRs than of night shifts. This is by any chance an inaccurate assumption. For one thing, studies on the effects of QRs have thus far almost exclusively focused on the short-term or acute consequences (e.g. sleep, sleepiness and fatigue), thus the long-term consequences are largely unexplored (Vedaa et al. 2016), while the long-term consequences of night shift are extensive and well documented (e.g. Kecklund and Axelsson 2016). Secondly, there may exist a higher selection of workers out of night shift work (Knutsson and Åkerstedt 1992) than out of shift work that includes QRs, which essentially would make night workers a self-selected group of workers that are better able to tolerate inconvenient working hours.

Limitations and further directions

A strength with the present study includes the large sample size together with the novelty of the research questions and its adjacent implications for practice. A limitation was the relatively low response rate in the first wave of the survey, which may reduce the generalizability of the findings. No information was available on non-responders.

Furthermore, there is a potential limitation in the recruitment strategy for the SUSSH cohort study, where eligible nurses were invited to participate by stratification on years after finalized education as a nurse. We do not know if this introduced any unknown bias. The proportion of nurses who reported QRs and night shifts in the present study were 38% and 27%, respectively. This is significantly fewer than reported previously by Norwegian nurses (Vedaa et al., 2017). It is possible that a population with more frequent exposures to QRs and

night shifts would have demonstrated different and possibly more unfavorable outcomes. The representativeness of the findings was also limited by the fact that the sample only comprised nurses, and with a significant female preponderance, albeit the sex distribution quite accurately reflects that of the Norwegian population of nurses as a whole. The present study should therefore be replicated in other occupational groups and on samples with a more equal sex distribution. The cross-sectional design of the present study precludes us from making assumption about causality. Future attempts to replicate these findings should preferably use longitudinal designs. Moreover, to reduce the risk of spurious causality and bias, there is a need for randomized controlled trials on the effects of QRs on occupational accidents and near-accidents. QRs are not indispensable in a shift system, unlike night shifts. It is therefore important that future studies establish the causal relationship between QRs and accidents (and other negative health effects), as the abolishment of QRs might potentially ease the burden on shift workers and provide significant socioeconomic return (e.g. in terms of fewer accidents). Furthermore, the exposure and outcomes variables in the present study were based on retrospective self-report data. This have obvious limitations for example in terms of recall bias (Weiss 1995). It should also be noted that the nurses answered questions that were constructed for the purpose of the present study, and these questions have not yet been validated albeit used in previous studies (Andreassen et al. 2018). Future studies should incorporate other measures of shift work exposures and accidents/near-accidents, for example by including supervisor ratings of accidents, work- and accident diaries, and objective indicators such as payroll data and archival records (e.g. of injuries on the shift workers as well as on others/patients).

Conclusion

This study showed that QRs were associated with seven of the eight items on accidents, near-accidents and dozing off at work that were investigated. Night shifts were associated with five of these items. It is particularly alarming that QRs were associated with nurses harming themselves and patients/others, and that night shifts were associated with dozing off while driving and causing harm to patients/others. Study designs that allow for causal inferences need to replicate these findings; meanwhile, our results provide an indication of the negative consequences of QRs and night shifts in terms of the risk of work-related incidents.

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Table 1. Descriptive statistics of demographics and work factors ($N = 1784$).

Variables	Percentage / Mean (SD)
Sex	
Female	90.9%
Male	9.1%
Age	40.1 (8.4)
Marital status	
Living with partner	79.8%
Living without partner	20.2%
Children in household	
No children	30.3%
Children in household	69.7%
Percentage of full time equivalent (FTE)	
>90%	59.6%
76-90%	19.3%
50-75%	18.3%
<50%	2.8%
Number of quick returns the last year (QRs)	28.0 (34.4)
Number of night shifts the last year	19.6 (35.0)

Table 2. Descriptive statistics for number of self-reported work-related accidents or near-accidents among Norwegian nurses (n=1784).

	Mean num. of times (SD)	Prevalence
Dozed off involuntarily at work the last month	0.84 (2.25)	457 (26%)
Dozed off while driving to/from work the last year	0.72 (4.75)	230 (13%)
Caused harm to yourself the last year	0.13 (0.85)	109 (6%)
Nearly caused harm to yourself the last year	0.31 (1.93)	165 (9%)
Caused harm to patients/others the last year	0.12 (0.73)	99 (6%)
Nearly caused harm to patients/others the last year	0.31(1.16)	268 (15%)
Caused harm to equipment the last year	0.18 (1.03)	159 (9%)
Nearly caused harm to equipment the last year	0.31 (2.17)	165 (9%)

Note. Prevalence refers to the total number of nurses (and percentages) reporting at least one of the respective incidents.

Table 3. Results from the negative binomial regression analyses on the association between number of quick returns and night shifts the last year and eight self-reported work-related accidents/near-accidents (N=1,784).

	Crude model			Fully adjusted model		
	IRR	95% CI	Sig.	IRR	95% CI	Sig.
Dozed off at work						
Quick returns	1.003	1.001-1.005	0.014	1.004	1.002-1.007	0.001
Night shifts	1.015	1.013-1.017	<0.001	1.015	1.013-1.018	<0.001
Dozed off while driving						
Quick returns	1.004	1.002-1.006	0.001	1.002	0.999-1.004	0.175
Night shifts	1.008	1.006-1.010	<0.001	1.009	1.006-1.011	<0.001
Harmed oneself						
Quick returns	1.010	1.006-1.013	<0.001	1.009	1.005-1.013	<0.001
Night shifts	0.999	0.995-1.004	0.744	1.000	0.995-1.005	0.882
Nearly harmed oneself						
Quick returns	1.008	1.005-1.010	<0.001	1.008	1.005-1.011	<0.001
Night shifts	1.000	0.997-1.003	0.791	1.002	0.999-1.005	0.270
Harmed patients/others						
Quick returns	1.007	1.003-1.011	<0.001	1.006	1.002-1.010	0.006
Night shifts	1.003	0.999-1.007	0.128	1.005	1.001-1.009	0.022
Nearly harmed patients/ others						
Quick returns	1.010	1.008-1.013	<0.001	1.011	1.008-1.014	<0.001
Night shifts	1.006	1.003-1.009	<0.001	1.006	1.004-1.009	<0.001
Harmed equipment						
Quick returns	1.011	1.008-1.014	<0.001	1.009	1.005-1.012	<0.001
Night shifts	1.002	0.999-1.005	0.231	1.001	0.997-1.006	0.554
Nearly harmed equipment						
Quick returns	1.007	1.004-1.010	<0.001	1.004	1.001-1.007	0.017
Night shifts	1.002	0.999-1.004	0.279	1.006	1.002-1.009	0.001

Note. The fully adjusted model is controlling for the shift exposures (night shifts and quick returns, respectively), sex, age, marital status, children in household, and percentage of full time equivalent. The rationale for including this list of confounders was that they define some of the basic elements of an individual's life situation and have all been found to account for part of the variance of work-related accidents/near-accidents in previous research.¹⁹⁻²²