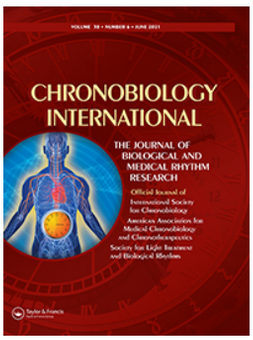

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Chronobiology International

The Journal of Biological and Medical Rhythm Research

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/icbi20

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To cite this article: Siri Waage, Ståle Pallesen, Bente Elisabeth Moen, Øystein Vedaa, Eirunn Thun, Hogne Vikanes Buchvold, Kjersti Marie Blytt, Anette Harris & Bjørn Bjorvatn (2021) Changes in work schedule affect the prevalence of shift work disorder among Norwegian nurses – a two year follow-up study, Chronobiology International, 38:6, 924-932, DOI: 10.1080/07420528.2021.1896535

To link to this article: https://doi.org/10.1080/07420528.2021.1896535

Published online: 18 Mar 2021.

CHRONOBIOLOGY INTERNATIONAL
2021, VOL. 38, NO. 6, 924–932
https://doi.org/10.1080/07420528.2021.1896535

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Changes in work schedule affect the prevalence of shift work disorder among Norwegian nurses – a two year follow-up study

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ABSTRACT

This study aimed to explore how changes in the work schedule would affect the prevalence of Shift Work Disorder (SWD) over time. Two-year follow-up data from 1076 nurses participating in the longitudinal SUrvey of Shift work, Sleep and Health among Norwegian nurses (SUSSH) were included in the study. The questionnaires included measures of work-related factors, i.e., work schedule and numbers of night shifts and quick returns (QRs) worked the last year, as well as questions related to SWD according to the ICSD-3 diagnostic criteria at both baseline and at 2-year follow-up. Data were analyzed with paired samples t-tests, chi-square tests, and logistic regression analyses adjusting for sex and age. Terminating night work was the strongest predictor for recovering from SWD from baseline to follow-up (OR 10.91, 95% CI 6.11–19.46). Additionally, changing the work schedule from day work to night work from baseline to follow-up was the strongest predictor for developing SWD in the same period (OR 4.75, 95% CI 2.39–9.47). Reductions in number of nights (more than 10) and QRs (more than 10) worked the last year were associated with recovering from SWD between baseline and follow-up. Nurses who recovered from SWD had significantly reduced the mean number of night shifts worked the last year from 32.3 at baseline to 20.4 at follow-up (p = .001). Furthermore, an increase of more than 10 nights or more than 10 QRs worked the last year between baseline and follow-up predicted developing SWD. Nurses developing SWD between baseline and follow-up had significantly increased the mean number of nights worked the last year from 25.8 at baseline to 31.0 at follow-up (p =-.043). Changes in night work exposure were the strongest predictors for both recovering from or developing SWD from baseline to follow-up. Reducing exposure to night work and QRs were associated with recovering from SWD and increasing exposure to night work and QRs were associated with developing SWD. The results imply that unfavorable work schedules play a role in the development of sleep problems among nurses. These results may be useful when designing healthy working schedules.

ARTICLE HISTORY
Received 10 December 2020
Revised 22 February 2021
Accepted 23 February 2021

KEYWORDS
Shift work disorder; work schedule; longitudinal cohort study; nurses

Introduction

Shift work is a form of work scheduling in which a group of workers succeeds one another temporally at the workplace in order to maintain operation (Pati et al. 2001). In general, shift work disrupts biological rhythms and is associated with a variety of adverse health outcomes, whereof sleep problems are among the most commonly reported complaints (Kecklund and Axelsson 2016). Especially, night work is associated with sleep problems, i.e., sleep maintenance difficulties, reduced sleep duration, and excessive sleepiness during work (Akerstedt 2003). In addition, short rest periods (<11 h) between two shifts, denoted as quick returns (QRs), are also reported to be associated with sleep problems, such as shortened sleep duration, disturbed sleep, and excessive daytime sleepiness (Booker et al. 2018; Eldevik et al. 2013; Vedaa et al. 2016). Shift work is very common in the health care sector in which nurses typically are involved in rotating shift work, including both night work and QRs (Sun et al. 2019).

Shift work disorder (SWD) is a circadian rhythm sleep-wake disorder characterized by excessive sleepiness and/or insomnia with concomitant sleep reduction due to work hours that overlap with the habitual time for sleep (Di Milia et al. 2013; Waage et al. 2009; Wright et al. 2013). SWD is associated with substantial adverse

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consequences to the individual, employers, and society, and is associated with impaired health (Wickwire et al. 2017). Workers with SWD have reported more health complaints and sleepiness-related accidents compared to workers without SWD (Bjorvatn et al. 2018; Waage et al. 2018; Wright et al. 2013). The mechanisms causing SWD are likely misalignments between shift workers' endogenous circadian rhythms and their sleep and work schedules, in which shift workers both attempt to sleep and work at a different phase than that natural according to their biological clock (Cheng and Drake 2019). Both working night shifts and having QRs are characteristics of shift work schedules associated with the presence of SWD (Asaoka et al. 2013; Waage et al. 2014).

In 2014, the third edition of the International Classification of Sleep Disorders (ICSD-3) updated the criteria for SWD (American Academy of Sleep Medicine 2014). The main change from the second edition comprised linking insomnia/sleepiness to reduction of total sleep time in relation to the work schedule. Additionally, the minimum duration of symptoms was increased from one to at least 3 months. It is estimated that SWD may occur in up to one-third of shift workers, with higher rates in night shift workers (Sachdeva and Goldstein 2020). In different shift work populations when using previous criteria from ICSD, the prevalence has been estimated to be between 10% and 63% (Drake et al. 2004; Taniyama et al. 2015; Waage et al. 2009). In nurses, specifically, dependent on type of work schedule, a prevalence ranging from 29% in two-shift rotation workers to 44% in three-shift rotation workers has been reported using the criteria from the second edition of the ICSD (Flo et al. 2012). The prevalence of SWD according to the newest SWD criteria is not much investigated and still unclear (Wickwire et al. 2017). However, one recent Finnish study reported prevalence rates between 3% (shift workers with no night work) and 10% (shift workers with night work) among hospital personnel using the newest criteria (Vanttola et al. 2020).

Still, previous research on SWD has been performed with different instruments to operationalize the disorder. Such instruments include measures of excessive sleepiness, sleep latency, sleep duration, sleep quality, and insomnia symptoms assessed with sleep diary, actigraphy, and questionnaires (Booker et al. 2018). In addition to the diversity in study populations and instruments, a wide variety of shift schedules have been studied. Furthermore, few studies addressing SWD using the updated ICSD-3 diagnostic criteria exist. In addition, most previous studies are cross-sectional, and, consequently, there is a need for longitudinal studies to be able to make causal inferences (Kecklund and Axelsson 2016; Wright et al. 2013). Some longitudinal studies on SWD using the ICSD-2 diagnostic criteria have suggested that work-related factors in terms of night work and QRs may be major causes of SWD (Flo et al. 2014; Waage et al. 2014). Consequently, new knowledge about shift work characteristics being associated with SWD, and how changes in such work characteristics could contribute to reduce SWD would be of importance both for shift workers at the individual level, but also at the organizational level. With this in mind, we revised three items based on the ICSD-2 that we have previously used in research on SWD (Flo et al. 2012; Waage et al. 2009, 2014) to adhere to the updated ICSD-3. The present study aimed to investigate SWD according to these revised criteria in a large population of nurses with a longitudinal follow-up design. Our goal was to explore how changes in the work schedule would affect the prevalence of SWD over time. We hypothesized that among nurses who changed their work schedule by reducing night work or QRs from baseline to follow-up, there would be a decrease in the prevalence of SWD. Furthermore, we hypothesized that among nurses who changed their work schedule by increasing night work or QRs from baseline to follow-up, there would be an increase in the prevalence of SWD.

Materials and methods

Procedure and participants

The present paper includes data collected from the longitudinal cohort study "**SU**rvey of **S**hift work, **S**leep and **H**ealth (SUSSH)" among Norwegian nurses. The first data collection was conducted during winter 2008/2009 (wave 1) when a sample of 5400 nurses was randomly selected from the Norwegian Nurses Organization's (NNO) membership roll and asked to participate in the survey. The NNO comprises most of the nurses in Norway. The initial sample comprised five equal strata based on the numbers of years since graduation from nursing school (0–11 months, 1–3 years, 3.1–6 years, 6.-1–9 years, and 9.1–12 years). A total of 2059 nurses completed the questionnaire at the first wave (2008/2009), yielding a response rate of 38.1%. In an effort to increase the sample size, an additional sample of 905 newly educated nurses (response rate = 33.0%) was recruited in 2009; thus, the total sample in the first wave included 2964 nurses. All nurses who responded to the first wave have since been invited to complete annual follow-up questionnaires, except for nurses who have withdrawn from the study, died, or have unknown addresses. Questionnaires have been sent by postal mail

with pre-paid envelopes for returning the completed questionnaire. Those who did not respond received up to two reminders. For each wave, nurses completing and returning the questionnaire participated in a lottery, where 25 individuals could win a gift card with a value of 500 NOK (~50 USD). The response rates in the follow-up questionnaires have been high, between 61% and 81%. The present study reports findings from wave 7 (year 2015 = baseline) and wave 9 (year 2017 = follow-up), since the wave in 2015 was the first using the revised items addressing SWD. In 2015, a total of 1877 nurses responded to the questionnaire, yielding a response rate of 67.6%. In 2017, a total of 1746 nurses responded to the questionnaire, yielding a response rate of 62.5%. Only those who reported that they were working as nurses in both 2015 and 2017 were included in the analyses, leaving a net sample of 1076 nurses in the present study.

Instruments

Work-related factors

The questionnaire included questions about work schedule (day only, evening only, two-shift rotation including day and evening shifts, night only, three-shift rotation including day, evening, and night shifts, and other schedules with night work), numbers of nights, and QRs worked last year. Four groups based on work schedule were created; 1) nurses with day work (day only, evening only, two-shift rotation) at both baseline and at follow-up (*"constant day work"*), 2) nurses with day work at baseline and night work (night only, three-shift rotation, other schedules with night work) at follow-up (*"starting night work"*), 3) nurses with night work at baseline and day work at follow-up (*"quitting night work"*), and 4) nurses with night work at both baseline and at follow-up (*"constant night work"*). Furthermore, three groups based on changes in night work exposure between baseline and follow-up were created: *no difference* (±10) in number of nights worked last year between baseline and follow-up, *decrease* (by 10 or more) in number of nights worked last year between baseline and follow-up, and *increase* (by 10 or more) in number of nights worked last year between baseline and follow-up. Similarly, three groups based on changes in QRs exposure between baseline and follow-up were created: *no difference* (±10) in number of QRs worked last year between baseline and follow-up, *decrease* (by 10 of more) in number of QRs worked last year between baseline and follow-up, and *increase* (by 10 or more) in number of QRs worked last year between baseline and follow-up.

Shift work disorder

SWD was assessed with three questions based on the criteria found in the ICSD-3 (American Academy of Sleep Medicine 2014). The questions were: a) Do you have a work schedule that sometimes overlap with the time you usually sleep? b) if yes, does this cause insomnia and/or excessive sleepiness due to reduced amount of sleep? c) if yes, has this lasted for at least three months? Participants were classified as having SWD when responding "yes" to all three questions. Four groups based on having or not having SWD at baseline and at follow-up were created; 1) nurses who did not have SWD at baseline or at follow-up (*"no SWD"*), 2) nurses who did not have SWD at baseline, but had SWD at follow-up (*"developing SWD"*), 3) nurses who had SWD at baseline, but not at follow-up (*"recovering from SWD"*) and 4) nurses who had SWD at both baseline and at follow-up (*"chronic SWD"*).

Statistics

IBM SPSS Statistics 25 for Windows was used for the statistical analyses. Paired samples t-tests were used to compare means, whereas chi-square and McNemar tests were used to compare categorical variables. Furthermore, crude and adjusted (for sex and age) logistic regression analyses were conducted with recovering from SWD between baseline and follow-up (not recovering from SWD = 0 and recovering from SWD = 1) as dependent variable. Similarly, crude and adjusted (for sex and age) logistic regression analyses were conducted with developing SWD between baseline and follow-up (not developing SWD = 0 and developing SWD = 1) as dependent variable. Change in work schedule between baseline and follow-up (*constant day work* as contrast), change in numbers of night shifts between baseline and follow-up (*no difference* (±10) as contrast), and change in numbers of QRs between baseline and follow-up (*no difference* (±10) as contrast) were included as independent variables. Tests to investigate if the data met the assumption of collinearity indicated that multicollinearity was not a concern, with variance inflation factor (VIF) scores between 1.02 and 1.47. Significance level was set to $p \leq .05$.

Ethics

The study was approved by the Regional Committee for Medical and Health Research Ethics of Western Norway (REK-West, no 088.08) and followed the ethical standards and methods outlined by Portaluppi et al. (2010).

Informed consent in written form was obtained from all participants.

Results

Most of the nurses were females (89.7%), and mean age in 2015 was 39.9 (SD = 8.4, range 28–65) y. Work characteristics are presented in Table 1. A total of 50.6% (n = 519) of the nurses reported day work at both baseline and follow-up, 4.9% (n = 50) of the nurses changed from day work to a work schedule including night work from baseline to follow-up, 8.5% (n = 87) of the nurses stopped working nights between baseline and follow-up, and 36.1% (n = 370) of the nurses worked night work at both baseline and follow-up. Among all of the nurses, independent of SWD status, reporting data for both baseline and follow-up, there was a significant decrease in mean number of nights worked the last year (baseline 21.7 vs. follow-up 21.0, paired t-test, $p = .03$) and mean number of QRs worked the last year (baseline 31.2 vs. follow-up 28.3, paired t-test, $p = .003$).

Table 1. Work characteristics and SWD of the nurses in the study at baseline and follow-up.

Work schedule at baseline (n = 1044)	
Day only (n = 242)	23.2%
Evening only (n = 1)	0.1%
Two-shift (day and evening) (n = 337)	32.3%
Night only (n = 70)	6.7%
Three-shift (day, evening and night) (n = 348)	33.3%
Other schedules with night work (n = 46)	4.4%
Work schedule at follow-up (n = 1056)	
Day only (n = 281)	26.6%
Evening only (n = 1)	0.1%
Two-shift (day and evening) (n = 339)	32.1%
Night only (n = 66)	6.3%
Three-shift (day, evening and night) (n = 329)	31.2%
Other schedules with night work (n = 40)	3.8%
Change in work schedule between baseline and follow-up (n = 1026)	
Constant day work (n = 519)	50.6%
Starting night work (n = 50)	4.9%
Quitting night work (n = 87)	8.5%
Constant night work (n = 370)	36.1%
Number of nights worked last year, mean (SD)	
Baseline (n = 1059)	21.9 (34.8)
Follow-up (n = 1061)	20.1 (34.7)
Change in numbers of nights worked last year between baseline and follow-up (n = 1045)	
No difference (±10) (n = 743)	71.1%
>10 decrease (n = 171)	16.4%
>10 increase (n = 131)	12.5%
Number of quick returns worked last year, mean (SD)	
Baseline (n = 1049)	31.1 (33.1)
Follow-up (n = 1052)	28.2 (32.3)
Change in numbers of QRs worked last year between baseline and follow-up (n = 1032)	
No difference (±10) (n = 569)	55.1%
>10 decrease (n = 260)	25.2%
>10 increase (n = 203)	19.7%
Shift work disorder (SWD)	
Baseline (n = 1073)	32.2%
Follow-up (n = 1061)	35.1%
Change in SWD between baseline and follow-up (n = 1058)	
No SWD at baseline or follow-up (n = 576)	54.4%
Developing SWD (n = 142)	13.4%
Recovering from SWD (n = 110)	10.4%
Chronic SWD (SWD at both baseline and follow-up) (n = 230)	21.7%

A total of 54.4% of the nurses neither had SWD at baseline nor at follow-up (no SWD), 13.4% of the nurses developed SWD from baseline to follow-up (developing SWD), 10.4% of the nurses had SWD at baseline but not at follow-up (recovering from SWD), and 21.7% of the nurses had SWD at both baseline and follow-up (chronic SWD) (see Table 1). The prevalence of SWD among the nurses increased from 32.1% at baseline to 35.2% at follow-up ($p < .0005$). Nurses with SWD were working significantly more night shifts the last year compared to nurses not having SWD at both baseline (mean 35.8 vs. 15.3, $p < .0005$) and follow-up (mean 33.9 vs. 12.9, $p < .0005$). Similarly, nurses with SWD were working significantly more QRs the last year compared to nurses not having SWD at both baseline (mean 39.5 vs. 27.0, $p < .0005$) and follow-up (mean 39.6 vs. 21.9, $p < .0005$).

The results from the logistic regression analyses are presented in Tables 2 and 3. The strongest predictor for recovering from SWD during the follow-up period was to stop working nights. Also, reductions in number of nights (more than 10) and QRs (more than 10) worked the last year were associated with recovering from SWD between baseline and follow-up (see Table 2). The full model containing all independent variables was statistically significant [$_X^2$ (9, N = 981) = 80.0, $p < .001$]. The explained variance ranged between 7.8% (Cox & Snell R2) and 16.2% (Nagelkerke R2). Furthermore, nurses recovering from SWD between baseline and follow-up reported a significant reduction in the average numbers of night shifts worked the last year, from 32.3 at baseline to 20.4 at follow-up ($p = .001$) (see Figure 1).

To start working night work between baseline and follow-up and working constant night work were the strongest predictors for developing SWD during the follow-up period. In addition, both an increase of more than 10 nights or more than 10 QRs worked the last year between baseline and follow-up predicted developing SWD (see Table 3). The full model containing all independent variables was statistically significant [$_X^2$ (9, N = 981) = 49.6, $p < .001$]. The explained variance ranged between 4.9% (Cox & Snell R2) and 9.1% (Nagelkerke R2). Among nurses developing SWD from baseline to follow-up, there was also a significant increase in the average number of nights worked last year, from 25.8 at baseline to 31.0 at follow-up ($p = .043$) (see Figure 1).

Table 2. Crude and adjusted logistic regression analyses with recovering from shift work disorder (SWD) between baseline and follow-up as the dependent variable among Norwegians nurses.

	Recovering from SWD OR (95% CI)[b]	Recovering from SWD OR (95% CI)[c]
Sex (n = 1054)		
Female	1.00	
Male	0.58 (0.26–1.28)	
Age (n = 1056)	0.98 (0.96–1.01)	
Change in work schedule (n = 1009)		
Constant day work[a]	1.00	1.00
Starting night work	1.81 (0.67–4.92)	1.92 (0.71–5.25)
Quitting night work	**10.88 (6.15–19.26)**	**10.91 (6.11–19.46)**
Constant night work	1.64 (0.98–2.73)	1.65 (0.98–2.77)
Change in numbers of nights worked last year (n = 1028)		
No difference (±10) [a]	1.00	1.00
>10 decrease	**3.44 (2.20–5.37)**	**3.48 (2.21–5.50)**
>10 increase	0.64 (0.29–1.43)	0.58 (0.24–1.38)
Change in numbers of QRs worked last year (n = 1016)		
No difference (±10) [a]	1.00	1.00
>10 decrease	**1.76 (1.12–2.78)**	**1.82 (1.14–2.90)**
>10 increase	1.25 (0.73–2.15)	1.30 (0.76–2.24)

[a]Comprised the reference/contrast group.
[b]Separate crude logistic regression analyses for each independent variable.
[c]Separate logistic regression analyses for each independent variable with adjustment for sex and age.
Significant findings are shown in **bold**.

Table 3. Crude and adjusted logistic regression analyses with developing shift work disorder (SWD) between baseline and follow-up as the dependent variable among Norwegians nurses.

	Developing SWD OR (95% CI)[b]	Developing SWD OR (95% CI)[c]
Sex (n = 1054)		
Female	1.00	
Male	1.55 (0.92–2.61)	
Age (n = 1056)	1.01 (0.99–1.03)	
Change in work schedule (n = 1009)		
Constant day work[a]	1.00	1.00
Starting night work	**4.56 (2.31–9.00)**	**4.75 (2.39–9.47)**
Quitting night work	0.38 (0.12–1.26)	0.40 (0.12–1.31)
Constant night work	**2.58 (1.73–3.84)**	**2.58 (1.72–3.86)**
Change in numbers of nights worked last year (n = 1028)		
No difference (±10) [a]	1.00	1.00
>10 decrease	1.36 (0.83–2.22)	1.40 (0.85–2.30)
>10 increase	**2.85 (1.81–4.48)**	**2.95 (1.86–4.68)**
Change in numbers of QRs worked last year (n = 1016)		
No difference (±10) [a]	1.00	1.00
>10 decrease	1.29 (0.82–2.01)	1.28 (0.81–2.01)
>10 increase	**2.22 (1.44–3.42)**	**2.21 (1.42–3.41)**

[a]Comprised the reference/contrast group.
[b]Separate crude logistic regression analyses for each independent variable.
[c]Separate logistic regression analyses for each independent variable with adjustment for sex and age.
Significant findings are shown in **bold**.

Discussion

The aim of this study was to explore how changes in the work schedule would affect SWD over time. The strongest predictor for recovering from SWD from baseline to follow-up was to stop working night shifts. Furthermore, changing the work schedule from day work to night work from baseline to follow-up was the strongest predictor for developing SWD in the same period. Both reductions in number of nights and QRs worked the last year were associated with recovering from SWD, while an increase in number of nights and QRs worked the last year were associated with developing SWD. Nurses who recovered from SWD had significantly reduced the number of night shifts during the follow-up period. Nurses developing SWD between baseline and follow-up had significantly increased the number of nights worked the last year in the same period. The findings indicated that the prevalence of SWD in

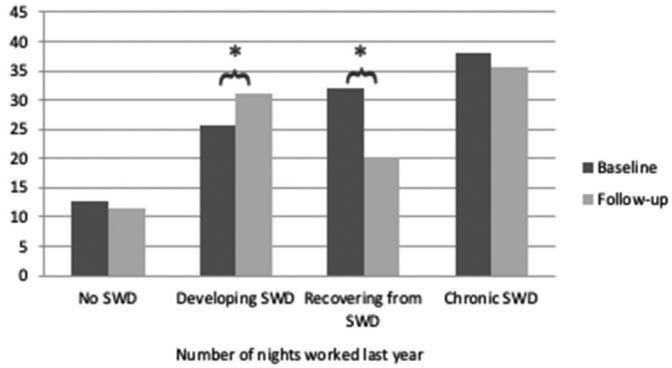

Figure 1. Mean number of nights worked last year at baseline and follow-up. SWD = shift work disorder. * = $p < .05$ on Paired samples t-tests.

the total sample was relatively high both at baseline and at follow-up, with a significant increase from 32.1% at baseline to 35.2% after the two-year follow-up period.

SWD has been associated with certain shift characteristics, and night work has been suggested to be the main precursor of SWD (Flo et al. 2012; Waage et al. 2014). However, recent evidence has suggested that shift workers may experience QRs as more problematic than night work (Dahlgren et al. 2016; Flo et al. 2014; Vedaa et al. 2017). In the present study, we thus focused on both night work and QRs as shift characteristics affecting SWD over time. As support for this notion, nurses with SWD in the present study were working significantly more night shifts and QRs at both baseline and follow-up, compared to nurses not having SWD. The results showed that to stop working night shifts from baseline to follow-up was the strongest predictor for recovering from SWD in the same period. Both reductions of more than 10 night shifts and more than 10 QRs worked the last year were associated with recovering from SWD. This lends support to our first hypothesis, that nurses who changed their work schedule by reducing night work experience a decrease in the prevalence of SWD. Furthermore, nurses recovering from SWD between baseline and follow-up reported a significant reduction in the average number of nights worked the last year from 32.3 at baseline to 20.4 at follow-up, and also a reduction in the average number of QRs from 34.0 to 29.6 (although the reduction was not significant), indicating that these shift characteristics may represent important factors in the maintenance of SWD among nurses.

Since both night work and QRs previously have been found to be predictors of SWD (Flo et al. 2014; Waage et al. 2014), we furthermore hypothesized that nurses who changed their work schedule by increasing night work and QRs from baseline to follow-up would report an increase in the prevalence of SWD. This hypothesis was also supported by our findings. Together with having constant night work, changing the work schedule from day work to night work from baseline to follow-up was the strongest predictor for developing SWD in the same period. Both having an increase of more than 10 night shifts and more than 10 QRs worked the last year also predicted development of SWD from baseline to follow-up. Furthermore, the results showed that among nurses who developed SWD from baseline to follow-up, there was a significant increase in the average number of nights worked last year. There was, however, no significant increase in the average number of QRs worked the last year in this group of nurses. This is in contrast to studies showing that QRs may have more negative impact on shift workers' sleep than night work (Dahlgren et al. 2016; Eldevik et al. 2013; Vedaa et al. 2017). In a previous one-year follow-up study among the same cohort of Norwegian nurses, an increase of QRs was associated with SWD only in the crude analysis, while the risk of SWD after one-year follow-up was positively related to the number of night shifts at baseline and to an increase in number of night shifts between measurements (Flo et al. 2014), which is in line with findings in the present study.

The prevalence of SWD was 32.1% and 35.2% at baseline and follow-up, respectively. This is in line with previous studies investigating SWD among nurses, in which prevalence rates are reported to be between 24.4% (Asaoka et al. 2013) and 44.3% among three shift workers (Flo et al. 2012). However, most previous studies have used the criteria for SWD from the second edition of the International Classification of Sleep Disorders (ICSD-2) (American Academy of Sleep Medicine 2005). It is still unclear how the changes made in the current ICSD-3 criteria will affect the prevalence rate, but it is reasonable to expect that the changes will lead to fewer cases of SWD (Vanttola et al. 2020). A reduction in prevalence is

expected because the most recent SWD criteria require a reduction in total sleep time associated with the work schedule, but also that the duration of symptoms is extended from 1 to 3 months. With that in mind, it is worth mentioning that the present study did not find considerably lower prevalence rates than what have been previously reported among these nurses using the ICSD-2 criteria (Flo et al. 2012; Waage et al. 2014). The recent Finnish study combining SWD symptoms and registry data performed among 9246 hospital personnel examined SWD using both ICSD-2 and ICSD-3 criteria and found that the prevalence was systematically lower when the latest ICSD-3 criteria (from 2.5% to 9.5% depending on work shifts) were used compared to the ICSD-2 (from 5.5% to 33.5% depending on work shifts) (Vanttola et al. 2020). The assumption that the latest criteria would lead to a lower prevalence of SWD was not found in the present study. The divergence in prevalences between the Finnish study and the present one could be related to factors, such as that the nurses in the present study consisted of an age group where sleep problems are known to increase, or that workers who are struggling with unfavorable working hours have problems to such degree that the reported sleep problems persist even with stricter criteria. In addition, the Finnish study calculated the prevalence of SWD by combining SWD symptoms and registry data, which may be considered to be more conservative than self-reported questionnaire data only, as used in the present study. However, our findings are comparable to a recent study performed among Chinese intern nurses exposed to first-time shift work (2-shift, 3-shift, and random shifts) also using the ICSD-3 criteria. They reported similar prevalence rates of SWD, with 35.2% at 3 months and 37.7% at 6-month follow-up, respectively (Chen et al. 2020). Although the prevalence rates were similar in the two studies, the Chinese study aimed to identify individual characteristics that predicted SWD onset among rotating shift working nurses, while the present study aimed to investigate how changes in the work schedule affected the prevalence of SWD. It should also be noted that the nurses in the Chinese study were much younger than the Norwegian nurses and one could thus expect the prevalence rate among the Chinese nurses to be lower compared to the Norwegian nurses. The two studies also differ in terms of SWD assessment which could also possibly affect the prevalence estimates.

During the two-year follow-up period, the prevalence rate of SWD in the total sample significantly increased. This stands in contrast to the findings from an earlier study, based on the same cohort, using the ICSD-2 criteria (Waage et al. 2014). That study also had a 2-year follow-up period in which the prevalence rate decreased from baseline to follow-up. The increase in the prevalence rate of SWD at follow-up is likely not explained by unfavorable changes in the work schedules, as both number of night shifts and number of QRs worked the last year in the total sample were significantly reduced from baseline to follow-up. However, during the two-year study period as many as 36.1% of the nurses had a work schedule involving night work at both baseline and follow-up, and 4.9% of the nurses started with night work over the study period, which could be one possible explanation for this increase. Yet, 8.5% of the nurses stopped working nights in the follow-up period, making this explanation more uncertain. The nurses in the present study had a mean age of nearly 40 y at baseline, and one could speculate if the increase in prevalence could be related to increased age in the study population, in accordance with previous findings showing that nurses having SWD are found to be slightly older than nurses without SWD (Waage et al. 2014) and that sleep problems related to shift work are reported to increase with age (Harma 1996).

Strengths and limitations

Several strengths of this cohort study deserve mention. First, the cohort is a relatively large sample size comprising a homogenous group of mostly female nurses. Second, the longitudinal design allows us to make inferences about directionality. Third, we used the latest criteria assessing SWD. However, the SWD diagnosis was solely based on questionnaire data and self-reports, and the study did not include any clinical evaluation or actigraphy data to verify the sleep and/or sleepiness problems or the reduction of sleep as required by the ICSD-3. This represents an important limitation. Still, the questions used in the study were designed based on the latest diagnostic criteria, and are also comparable to questions used in previous studies (Flo et al. 2012; Waage et al. 2009). Another limitation that should be noted is the relatively low response rate in the initial wave of the study, which may question the subsequent representativeness of the findings. Nevertheless, the response rates in all the follow-up waves have been high, between 61% and 81%. In this study, we observed a reduction in the number of night shifts and QRs from baseline to follow-up. It is unlikely that this reflects a real reduction in the presence of these shifts (especially night shifts) at the workplaces. Instead, this may indicate a selection mechanism in which those who have disadvantageous shifts tend to be non-responders. As in all shift work studies, the healthy worker effect represents a possible selection bias. Nurses suffering from health problems related to the work schedule would possibly choose to change jobs or change their schedule into day only work,

which may lead to an underestimation of the effects of night work in the present study. However, in the present study we believe that by using the change scores in relation to work schedules we to some degree adjust for this potential bias. In addition, the sample comprised mostly female nurses, limiting the possibilities for generalizing to males and other occupational groups.

Conclusion

A consistent pattern emerged in findings of the study, in which both the presence of frequent night shifts and QRs in the work schedule, and changes in the work schedule regarding an increase in such shifts, were associated with an increased risk of having SWD over time. Conversely, the absence of night shifts and QRs and a reduction in these exposures were associated with a reduced risk of having SWD over time. The results are thus unambiguous as to the role that unfavorable work schedules play in the development of sleep problems among nurses. As SWD is associated with substantial adverse consequences, these results may be useful when designing working schedules. Minimizing the number of night shifts and QRs will likely reduce the risk of SWD among nurses. Future studies should examine the effect of reducing or abolishing QRs from the work schedule.

Acknowledgements

This study received a grant for practical administration and data collection from The Western Norway Regional Health Authority (grant number 911386, no personal payment/salary). The Norwegian Nurses Organisation has provided grants to cover some of the running expenses of the SUSSH. The study was further partly funded from Nordforsk, Nordic Program on Health and Welfare (74809).

Disclosure statement

All authors declare no conflict of interest in relation to this paper.

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