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## The relationship of shift work disorder with symptoms of depression, anxiety, and stress

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### Abstract

Shift workers commonly suffer from disturbed sleep, which is known to affect mental health in other populations. Shift work disorder (SWD) is characterized by complaints of insomnia and/or excessive daytime sleepiness temporally associated with working non-standard schedules that occur during the usual time for sleep. Few studies have explored the extent to which workers with vs. without SWD experience worse mental health. We administered the Shift Work Disorder Screening Questionnaire to 60 adults engaged in various shift work schedules to categorize workers as being at high or low risk for SWD. Mental health outcomes were measured using the Depression Anxiety Stress Scale-21 (DASS-21). Linear regression was performed for each DASS-21 subscale, adjusting for age, sex, shift type, sleep duration, and frequency of alcohol use. Most participants (55 %) were at high risk for SWD. High-risk participants had higher depressive symptoms than low-risk participants,  $B = 3.59$ , 95 % CI [0.54, 6.65],  $p = .02$ . The estimated value for those at high risk for SWD corresponded to clinically significant mild depressive symptoms, ( $M = 13.43$ ), compared to those at low risk, ( $M = 9.84$ ). High risk for SWD was marginally associated with increased stress symptoms,  $B = 2.48$ , 95 % CI [-0.06, 5.02],  $p = .06$ . Our findings add to the body of evidence that SWD is associated with poor mental health outcomes. Providing interventions specific to the sleep impacts of SWD, including tailored cognitive behavioral therapy for insomnia, may improve shift workers' mental health.

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Declaration of Competing Interest

None.

## Keywords

Shift work; Sleep; Depression; Anxiety; Stress; Circadian

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## 1. Introduction

Sleep disturbance can contribute to mental health risk. Cross-sectional and longitudinal studies have shown an association between sleep disturbance and the presence and development of depression and anxiety (Alvaro et al., 2013; Baglioni et al., 2011). Recent work further suggests that sleep has a causal influence on mental health, as therapeutic interventions and randomized clinical trials targeting sleep problems improve depression and anxiety (Scott et al., 2021). Disrupted circadian rhythms also relate to mental health risk (Walker et al., 2020).

The impact of sleep and circadian rhythm disturbances on mental health is particularly important for shift workers. In longitudinal studies, shift work is associated with adverse mental health outcomes, especially depression (Torquati et al., 2019). The susceptibility of these individuals to mental health risk is likely in part due to the combination of sleep disruption and circadian misalignment that occurs as a result of working non-standard shifts (Kervezee et al., 2018). Shift work disorder (SWD) is a circadian rhythm sleep disorder that is temporally associated with shift schedules and is characterized by insomnia symptoms during the sleep episode and sleepiness during the wake episode (International Classification of Sleep Disorders, 2014). Few studies to date have examined the relationship between SWD and mental health outcomes. Here, we administered the Shiftwork Disorder Screening Questionnaire (SWDSQ) to a diverse group of shift workers to examine how risk for SWD relates to depression, anxiety, and stress.

## 2. Method

Participants were recruited via social media and online advertisements and completed an online survey that included measures of their sleep and mental health. Inclusion criteria were ability to complete the survey in English, age ≥ 18 years, and engagement in any shift work schedules. Procedures were approved by the Monash University Human Research Ethics Committee (*Project ID: 20,526, Approved: 12/02/2019*).

Participants completed the 4-item SWDSQ, a validated questionnaire that categorizes individuals as either high or low risk for SWD based on International Classification of Sleep Disorders criteria (Barger et al., 2012). Participants complete questions on a 4-point scale, rating the severity of their symptoms over the prior month pertaining to sleep, sleepiness, and well-being in response to shift work. Mental health outcomes were assessed with the Depression Anxiety Stress Scale-21 (DASS-21), a 21-item questionnaire that assesses the severity of symptoms over the past week (Lovibond and Lovibond, 1995). Higher scores on each DASS-21 subscale (i.e., depression, anxiety, and stress) indicate higher symptom severity. Alcohol use frequency was collected using the questions “Do you drink alcohol?” and “If yes, how often do you drink alcohol?” Responses were coded as unit of times per month (0, 0.5, 2, 4, 10, 18 times per month). Age, sex, shift type, job, and typical sleep

duration on work days (“On work days, how many hours of actual sleep do you get during your main sleep episode?”) were collected by participant self-report.

Data were collected using Qualtrics software, version (8/2019) (Qualtrics, Provo, UT). Data analyses were conducted in SAS software, version 9.4 (2013) (SAS Institute Inc., Cary, NC). A separate multiple linear regression model was performed for each outcome: depressive, anxious, and stress symptoms. In each model the primary predictor was risk for shift work disorder (high, low). The models were adjusted for age, sex, shift type (reference: evening shift), sleep duration on work days, and alcohol use frequency.

### 3. Results

Participants ( $n = 60$ ) were (mean [ $SD$ ]) 37.0 (12.2) years old, including 36 females and 24 males. Participants were not racially diverse; 90.0 % ( $n = 54$ ) of participants were White, 6.7 % ( $n = 4$ ) were Asian, and 3.3 % ( $n = 2$ ) reported other race. Participants were from Australia ( $n = 35$ ), United States ( $n = 17$ ), United Kingdom ( $n = 3$ ), Canada ( $n = 3$ ), New Zealand ( $n = 1$ ), and South Africa ( $n = 1$ ). Shift work schedules varied, including early morning shifts (6.7 %), evening/swing shifts (6.7 %), night shifts (18 %), rotating shifts (including forward and backward rotating shifts; 35 %), and other shifts (including on-call and 24-hour shifts; 33 %). Participants were identified from four work sector types, including health care (e.g., nurses; 43 %), emergency responders (e.g., firefighters; 35 %), goods and services (e.g., bartenders; 12 %), and transport (e.g., truck drivers; 10 %).

Participants reported sleeping an average of 5.93 h ( $SD = 1.31$ ) on work days. Over half of participants (55 %) were at high risk for SWD. Most participants (80.0 %) reported sleeping fewer than 7 h on work days. See Table 1 for participants’ demographic, work-related, and sleep characteristics, as well as mental health symptoms across the sample, and separately by shift work disorder status.

The model predicting depressive symptoms was not significant overall,  $F(9, 50) = 1.61$ ,  $p = .14$ ,  $R^2 = 0.22$ . This test of the overall model evaluates whether the *joint* effect of *all* modeled predictors—considered together as a whole—improves the model fit relative to a model without those predictors. We report the significance testing for the overall model for the sake of completeness, but note that our primary research question is not about testing the overall model but rather about understanding the extent to which the predictor of SWD risk explains unique variance in the psychological outcomes over and above the effects of the other modeled predictors. Participants at high vs. low risk for shift work disorder reported significantly higher depressive symptoms, after adjusting for age, sex, shift work type, sleep duration on work days, and alcohol use frequency,  $B = 3.59$ ,  $SE = 1.52$ , 95 % CI [0.54, 6.65],  $p = .02$ . The model’s estimated value for those at high risk for shift work disorder was 13.43 ( $SE = 4.41$ ), which corresponds to the upper range of mild depressive symptoms and is above the cut-off point separating the normal non-clinical range from a clinical outpatient range corresponding to a population seeking mental health treatment (Lovibond and Lovibond, 1995; Ronk et al., 2013). In contrast, the estimated value for those at low risk was 9.84 ( $SE = 4.74$ ). Alcohol use frequency was marginally positively associated with

depressive symptoms,  $B = 0.27$ ,  $SE = 0.15$ , 95 % CI  $[-0.05, 0.58]$ ,  $p = .09$ ). No other variables were significant in this model, all other  $ps \geq 0.32$ .

The model predicting stress symptoms was overall not significant,  $F(9, 50) = 1.60$ ,  $p = .14$ ,  $R^2 = 0.22$ . High vs. low risk of shift work disorder was marginally associated with greater stress symptoms,  $B = 2.48$ ,  $SE = 1.26$ , 95 % CI  $[-0.06, 5.02]$ ,  $p = .06$ . The model's estimated value for those at high risk for shift work disorder was 15.89 ( $SE = 3.67$ ), which corresponds to mild stress (Lovibond and Lovibond, 1995), and the estimated value for those at low risk was 13.41 ( $SE = 3.94$ ). Higher age was associated with lower stress symptoms,  $B = -0.11$ ,  $SE = 0.05$ , 95 % CI  $[-0.22, -0.01]$ ,  $p = .03$ . No other factors were associated with this outcome, all other  $ps \geq 0.14$ .

The model predicting anxiety symptoms was overall not significant,  $F(9, 50) = 0.75$ ,  $p = .66$ ,  $R^2 = 0.12$ . Risk of shift work disorder was not associated with anxiety,  $p = .35$ . There were no other factors that were associated with this outcome, all other  $ps \geq 0.20$ .

We also tested three additional exploratory models. These models used the same parameters as the three tested models above but with the additional inclusion of work sector as a categorical factor (groups: emergency, healthcare workers, goods and services [set as comparison group], and transport; see Table 1 for prevalence information). In the exploratory model of depressive symptoms, participants at high vs. low risk for shift work disorder reported significantly higher symptoms, even after accounting for all other factors,  $B = 3.43$ ,  $SE = 1.55$ , 95 % CI  $[0.31, 6.55]$ ,  $p = .003$ . No other factors were significant, all  $ps \geq 0.17$ . In the model of stress symptoms, as in the parallel original model, risk of shift work disorder was again marginally associated with stress symptoms,  $B = 2.44$ ,  $SE = 1.29$ , 95 % CI  $[-0.15, 5.03]$ ,  $p = .06$ , and only age was significantly associated with stress symptoms,  $B = -0.14$ ,  $SE = 0.06$ , 95 % CI  $[-0.25, -0.03]$ ,  $p = .02$ ; all other  $ps \geq 0.21$ . In the model of anxiety symptoms, as in the parallel original model, risk of shift work disorder was again not associated with stress symptoms,  $p = .41$ , and no other factors were significant, all other  $ps \geq 0.18$ . Note that these exploratory models should be interpreted with some caution because the variance inflation factors exceeded 5 for multiple predictors due specifically to overlap between shift type and work sector (Akinwande et al., 2015).

#### 4. Discussion

High risk for SWD was common among this group of mixed-schedule shift workers, occurring in over half of the sample. Individuals with high risk for SWD reported experiencing shorter sleep, and having high risk for SWD was associated with higher severity of depression symptoms to a clinically significant degree. This relationship persisted when accounting for other variables that are related to depression, such as age, sex, sleep duration, and alcohol use. Our findings add to the evidence base demonstrating a link between SWD and mental health. They are also consistent with one of the only other studies that systematically assessed risk of SWD with the SWDSQ and found an association between SWD risk and depression symptoms (Booker et al., 2020). That prior study focused on hospital nurses on regular rotating or permanent night shifts, whereas ours includes

workers from several work sectors who were engaging in the full range of shift schedule types.

Aside from those study strengths (i.e., use of the validated SWDSQ, a sample including a wide range of shift types and work sectors), our exploratory study had limitations including a small sample size, cross-sectional design, and no circadian phase markers. Although our sample included both males and females in roughly equal numbers, the small sample size precludes sex-based comparisons. There is evidence that females have reduced tolerance to shift work than males, as demonstrated by more pronounced sleep problems, fatigue, and sleepiness (Saksvik et al., 2011). A larger, prospective study, powered to detect sex differences can help inform more personalized approaches to maintaining good sleep and mental health in shift workers. Finally, the findings regarding individual predictors should be interpreted cautiously in light of the non-significance of the overall model results, which may have occurred due to the small sample size being under-powered. A larger study can reveal whether the pattern of associations with risk of shift work disorder are reliable.

The relationships between sleep disturbance and mental health are apparent, although the nuances of the link are still being defined. For instance, although a bidirectional relationship is likely, evidence suggests that insomnia is a stronger predictor of the development of depression than depression is of developing insomnia. (Alvaro et al., 2013) This suggests that sleep may represent a potential target for interventions to reduce the mental health burden commonly facing shift workers. Recent trials administering cognitive behavioral therapy for insomnia (CBT-I) have demonstrated that this sleep-focused approach is effective in also improving depression and anxiety symptoms (Luik et al., 2017). Encouragingly, CBT-I can be adapted to address shift work-specific causes of insomnia (e.g., circadian misalignment) (Cheng, 2022). Considering the associations between SWD and depression, these tailored approaches to CBT-I should consider domains of mental health as additional outcomes. Poor sleep hygiene has also been found to be associated with risk for SWD (Booker et al., 2020), and is another viable behavioral target that may be harnessed to improve sleep and downstream mental health outcomes in shift workers.

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**Table 1**

Descriptive statistics for study sample.

Characteristic	Low risk for SWD ( <i>n</i> = 27)	High risk for SWD ( <i>n</i> = 33)	Full sample ( <i>n</i> = 60)
<b>Age (mean, <i>SD</i>, in years)</b>	36.33 (12.12)	37.55 (12.44)	37.00 (12.21)
<b>Sex</b>			
Female	17 (28.33 %)	19 (31.67 %)	36 (60.00 %)
Male	10 (16.67 %)	14 (23.33 %)	24 (40.00 %)
<b>DASS (mean, <i>SD</i>)</b>			
Depression	3.85 (4.10)	8.12 (5.98) **	6.20 (5.60)
Anxiety	3.26 (3.48)	4.73 (4.65)	4.07 (4.19)
Stress	6.07 (3.73)	9.03 (4.96) *	7.70 (4.66)
<b>Sleep duration on work days (mean, <i>SD</i>, in hours)</b>	6.31 (1.31)	5.61 (1.24) *	5.93 (1.31)
<b>Shift type frequency</b>			
Early morning	3 (5.00 %)	1 (1.67 %)	4 (6.67 %)
Evening	3 (5.00 %)	1 (1.67 %)	4 (6.67 %)
Night	4 (6.67 %)	7 (11.67 %)	11 (18.33 %)
Rotating	8 (13.33 %)	13 (21.67 %)	21 (35.00 %)
Other	9 (15.00 %)	11 (18.33 %)	20 (33.33 %)
<b>Work sector frequency</b>			
Health care	11 (18.33 %)	15 (25.00 %)	26 (43.33 %)
Emergency responders	10 (16.67 %)	11 (18.33 %)	21 (35.00 %)
Goods and services	4 (6.67 %)	3 (5.00 %)	7 (11.67 %)
Transportation	2 (3.33 %)	4 (6.67 %)	6 (10.00 %)
<b>Alcohol frequency per month (mean, <i>SD</i>)</b>	3.09 (5.32)	4.03 (4.90)	3.61 (5.08)

*Note.* Differences between groups on continuous outcomes were tested using independent-samples *t*-tests and on categorical outcomes were tested using chisquare tests. DASS = Depression Anxiety Stress Scales. *SD* = standard deviation. SWD = shift work disorder.

\* *p* < .05.

\*\* *p* < .01.