Association of Shift Work with Mood Disorders and Sleep Problems According to Chronotype: A 17-year Cohort Study

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**Declaration of Interest**

The authors report no conflict of interest.

**Data availability**

The data that support the findings of this study are available from the corresponding author, WJC, upon reasonable request.
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Abstract

Both evening chronotype and shift work are associated with depressive symptoms. This study examined whether the association between shift work and mood disorders and sleep problems varies by chronotype. The study population included 10,312 participants from the Finnish Hospital Personnel Cohort Study. Work schedule was assessed using repeated questionnaires between 2000 and 2017. Chronotype, assessed using a single item from the Diurnal Type Scale, was categorized into definite morning, somewhat morning, somewhat evening, and definite evening types. The presence of mood disorders was identified by the 12-item General Health Questionnaire. Sleep problems were assessed by self-reported frequency of difficulty falling asleep and maintaining asleep. Longitudinal fixed effects models were used to examine the associations between shift work and the presence of mood disorders and sleep problems, stratified by chronotype. We found that fixed night work was associated with mood disorders among somewhat evening (adjusted odds ratio [OR] 1.91, 95% CI 1.09–3.34) and definite evening-type workers (adjusted OR 2.05, 95% CI 1.06–3.98). Shift work with night shifts was associated with mood disorders among definite evening-type workers (adjusted OR 1.75, 95% CI 1.18–2.60). Similarly, fixed night work was associated with difficulty maintaining sleep only among evening-type workers. In conclusion, evening chronotype increase the vulnerability to mood disorders and sleep disturbances related to night work.

Keywords: Anxiety; depression; sleep; night work; chronotype, morningness;
eveningness
Introduction

Shift work is a prominent environmental feature of contemporary work. Shift work and night work have been found to be associated with an increased risk of poor mental health (Zhao et al. 2019). Disruptions of circadian sleep rhythm, hormone regulation, and metabolic functions are plausible mechanisms underlying the association with adverse mental health outcomes (McClung 2013). The extent to which shift work disrupts the circadian rhythm may be partially dependent on personal preferences of timing for sleep and activity, measured as the chronotype (Roenneberg et al. 2007). Environmental factors are estimated to account for 50%–55% variance in the chronotype (van de Ven et al. 2016), and a review suggested that workers with the late chronotype have better shift work tolerance regarding sleep and alertness than those with morning types, but they had worse work performance, mood, and work satisfaction (Saksvik et al. 2011). In addition, chronotype-adjusted shift scheduling is reported to correlate with longer sleep duration and better sleep quality among shift workers (Vetter et al. 2015), although the effect on mood has not been examined. Shift work provides an opportunity for researchers to explore interactions between environmental light–dark cycle changes and the chronotype and to test links between circadian rhythm disturbance and the development of mental illness.

Recent studies have determined that the evening chronotype is associated with more severe mood symptoms (Au and Reece 2017; Melo et al. 2017), whereas the morning chronotype is associated with positive personality traits (Lipnevich et al. 2017). Advancing sleep time reduced depression, stress, and cognitive and physical performance among people with the evening chronotype (Facer-Childs et al. 2019). Furthermore, chronotype has been observed to affect the relationship between shift work and cancer (Dickerman et al. 2016; Leung L. et al. 2019) and cardiometabolic
risks (Ritonja et al. 2019). Nevertheless, whether the chronotype modifies the association between shift work and mood disorders remains unclear.

The association between shift work and depressive disorder is often underestimated, because depressive symptoms usually persist for a period before a diagnosis is made. Instead of diagnosis of depressive disorder, many studies have used valid tools to measure mood disorders, including the General Health Questionnaire (GHQ). As a screening tool for mood disorders, including depressive and anxiety disorders (Aalto et al. 2012; Goldberg et al. 1997), the GHQ-12 is also valid for detecting relevant health and productivity issues in the workplace. The GHQ-12 is suitable for detecting short-term changes in mood disorders in response to work schedules, because it is sensitive to temporal and situational factors (Furnham and Cheng 2019). Furthermore, employees experiencing mood and insomnia symptoms tend to leave shift work and change their work schedule relatively quickly (De Raeve et al. 2009; Driesen et al. 2011). Possible changes in the work schedule during a longer follow-up period are rarely considered in longitudinal studies. Using longitudinal data of work schedules of shift workers, this study aimed to examine associations between shift work and mood disorders as well as the sleep problems of workers with differing chronotypes.

**Methods**

**Study participants**

Data were obtained from six waves of the Finnish Public Sector (FPS) study between 2000 and 2017. The FPS study comprised two cohorts: the ten-town cohort, a study of local government employees in ten towns, and the Work and Health in Finnish Hospital Personnel Study, a study conducted in 21 hospitals. Response rates were between 67% and 72%. In this study, due to differences in questionnaire design, only those who
participated in at least two surveys of the Finnish Hospital Personnel Study were included (N = 22 153). The Ethics Committee of the Hospital District of Helsinki and Uusimaa (HUS) approved the FPS study (HUS 1210/2016), which additionally conforms to the ethics for biological rhythm research on human beings (Portaluppi et al. 2010).

**Measurement of working schedule**

In six waves of questionnaires, the participants self-reported their current work schedule either as day work, shift work without night shifts, shift work with night shifts, fixed night work, or other irregular work. Those who reported other irregular work (n = 109, figure 1) were excluded from this study. The work schedule items used are validated against an objective measure of shift work status based on payroll data (Harma et al. 2017).

**Identifying mood disorders and sleep problems**

The presence of mood disorders was detected using the GHQ-12. The participants rated how much they were affected by 12 mood symptoms over the previous few weeks (0 = not at all, 1 = the same as usual, 2 = rather more than usual, or 3 = much more than usual). The answers were dichotomized as no distress for 0 and 1, and distressed for 2 and 3. Those who had ≥4 distressed responses were categorized as experiencing mood disorders. A cutoff GHQ-12 score of 3 or 4 has been recommended to screen psychiatric patients from the general population; this cutoff score displayed good sensitivity and specificity in relation to mood and anxiety disorders (Holi et al. 2003).

Sleep problems were assessed based on the reported frequency of having trouble falling asleep or maintaining sleep during the previous 4 weeks (Jenkins et al. 1988).
The participants chose between not at all, 1–3 days a month, 1 night per week, 2–4 nights per week, 5–6 nights per week, and every day. Sleep problems were defined as experiencing symptoms two or more nights per week, where the reference was <3 days a month.

**Measurement of chronotype and other variables**

Chronotype was assessed using one item from the Diurnal Type Scale (Torsvall and Akerstedt 1980) in the 2015 survey: “Do you think you are a morning person or an evening person?” The respondents chose between definite morning type, somewhat morning type, somewhat evening type, or definite evening type (Dickerman et al. 2016; Koskenvuo et al. 2007). Self-classified diurnal preference is highly correlated with the chronotype derived from more comprehensive questionnaires (Roenneberg et al. 2007). Chronotype responses were available for 10,637 employees who participated in the 2015 survey (Figure 1).

Psychosocial job demands were evaluated using three questions (hard work, insufficient time, and a lot of work) derived from the original Job Content Questionnaire using the job strain model of Karasek and Theorell (Karasek and Theorell 1990). The responses were recorded using a 5-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree), and the mean scores were ranked and divided into tertiles (low, medium, and high).

**Statistical analysis**

Distributions of age, gender, sleep problems, and mood disorders by work schedule were determined, and differences were examined using chi-square tests. A fixed effects logistic regression model was used to examine intraindividual associations between
changes in work schedule and changes in mood disorders as well as sleep problems. A longitudinal, fixed effects model has the advantage that when intraindividual changes over time are examined, time-invariant known and unknown confounders are eliminated (Gunasekara et al. 2014). Thus, the study participants served as their own controls. The interaction effect of the work schedule and chronotype (treated as a time-invariant variable) on mood disorders was examined. We then stratified the participants by chronotype into four groups (i.e., definite morning type, somewhat morning type, somewhat evening type, or definite evening type), and associations between work schedule and mood disorders were examined for each chronotype group. In crude models, work schedule and survey years were included as time-dependent variables. In the adjusted models, we added working hours and job demands as time-dependent variables. SAS 9.4 was used for all analyses.

**Results**

The mean age of the participants was 44.2 ± 10.4 y, and 88.2% identified themselves as women. The chronotype significantly varied among the four work schedule groups (Table 1), showing that the evening type was more prevalent among night shift workers. The overall prevalence of mood disorders was 21.1% and did not vary by work schedule. Nevertheless, the prevalence of mood disorders significantly differed by chronotype. Specifically, 20.8%, 19.8%, 20.6%, and 24.6% of definite morning-, somewhat morning-, somewhat evening-, and definite evening-type workers, respectively, had mood disorders. The prevalence of sleep problems was significantly different by work schedule; shift work without night shifts showed the highest prevalence of sleep problems.

In fixed effects logit models, a significant interaction effect between shift work
with night shifts and chronotype was observed, both in the crude model (p = 0.04) and the adjusted model (p = 0.03). Fixed night work was associated with mood disorders among somewhat- (OR 2.01, 95% CI 1.16–3.49) and definite evening-type workers (OR 2.01, 95% CI 1.06–3.82) (Table 2). The results remained significant after adjusting for working hours and job demands. Shift work with night shifts was significantly associated with mood disorders among definite evening-type workers in both crude (OR 1.90, 95% CI 1.30–2.78) and adjusted models (OR 1.75, 95% CI 1.18–2.60). Among somewhat evening-type workers, shift work without night shifts was associated with mood disorders in the crude model, but not in the adjusted model (OR 1.35, 95% CI 1.00–1.83, p = 0.05).

Similarly, shift work with night shifts was associated with difficulty falling asleep (Table 3) among definite evening-type workers (adjusted OR 3.62, 95% CI 2.00–6.56) and somewhat evening-type workers (adjusted OR 2.23, 95% CI 1.43–3.48). Fixed night work was associated with difficulty maintaining sleep (adjusted OR 2.45, 95% CI 1.18–5.09) for somewhat evening-type workers. Shift work without night shifts was associated with difficulty falling asleep among somewhat evening-type workers (adjusted OR 1.81, 95% CI 1.14–2.87). The work schedule was not associated with sleep problems among morning-type workers.

**Discussion**

We observed an interaction between shift work and chronotype on mood disorders and sleep problems. Compared with shift workers with the morning chronotype, those with the evening chronotype were more vulnerable to mood disorders and sleep problems.

A systemic review suggested that being an evening-type was positively associated with shift work tolerance in terms of sleep quality, while being a morning-type was
positively associated with mood and social performance (Saksvik et al. 2011). In the current study, evening-type workers were more likely to report mood disorders or sleep problems than were morning types. To date, few studies have simultaneously examined chronotype, shift work, and mood symptoms. In a small longitudinal study of fast-rotating shift nurses, both night work and early chronotype predicted mood symptoms (Bohle and Tilley 1989). Another longitudinal study observed that chronotype was not associated with depressive or anxiety symptoms, but circadian rhythm languidity (difficulties overcoming drowsiness following reduced sleep) was (Thun et al. 2014). Because the evening chronotype is associated with languidity (Baehr et al. 2000; Marcoen et al. 2015), evening-type workers may experience more drowsiness than morning-type workers, which in turn may lead to mood disorders. Although the interaction effect of chronotype and shift work on mental health is inconclusive due to an inadequate number of empirical studies, emerging studies have explored the link between the evening chronotype and mental health.

Our results showed an association between the evening chronotype and mood disorders, which is consistent with findings of several review studies (Au and Reece 2017; Kivela et al. 2018; Melo et al. 2017; Taylor and Hasler 2018). Possible mechanisms for this association include shared genetic factors between the evening chronotype and mood symptoms and a mediating role of insomnia (Au and Reece 2017; Taylor and Hasler 2018). The evening chronotype is associated with poorer sleep quality relative to the morning chronotype among shift workers (Asaoka et al. 2013). However, when sleep conditions and specific shifts are considered, workers with the evening type have shorter sleep duration and worse sleep quality during morning shifts than do those with the morning type (Togo et al. 2017; van de Ven et al. 2016). In this study, evening-type workers had more sleep problems when they worked a shift
schedule compared with a day work schedule. Because the average percentages of night shift and evening shift were 15% and 19%, respectively, among the FPS cohort shift workers (Harma et al. 2015), our finding may be explained by evening-type workers experiencing more sleep problems during morning shifts and days off. Findings may differ for workers with a shift schedule that consists of a high percentage of non–day shifts or only a few days off. Nonetheless, the mediating role of sleep problems in the association between shift work and mood disorders remains unclear due to the reciprocal relationship between insomnia and various mood symptoms (Taylor and Hasler 2018).

Another factor that links shift work to the association between the evening chronotype and mood disorders is artificial light exposure. Artificial light exposure suppresses melatonin production (Revell and Skene 2007). Therefore, night shifts would alter melatonin levels and diurnal patterns. Furthermore, evening-type workers are more susceptible to light-at-night disturbance of melatonin secretion than are morning-type workers (Leung M. et al. 2016), and long-term shift work is associated with decreased melatonin secretion only among evening-type workers (Leung M. et al. 2016). Low melatonin secretion is associated with subclinical depressive symptoms and poor sleep (Rahman et al. 2010), which may explain our observation of the vulnerability among evening-type shift workers to mood disorders.

The strengths of this study are that we utilized data collected from a large longitudinal cohort and that we used fixed effects models to control time-invariant factors. Therefore, the association between shift work and mood disorders was not confounded by individual risks of mood disorders, such as childhood traumatic events or genetic vulnerability. However, time-variant confounders not included in the models, such as current stressful life events or major physical illnesses, may confound the results.
Another limitation is that chronotype was measured using only one question. Therefore, we were unable to determine intraindividual changes in the chronotype over time. Furthermore, we did not use objective tools to measure chronotype, such as dim-light melatonin onset or actigraphy repeated with different shift schedules, to provide more precise information on quantitative changes in chronotype and its relationship with mood symptoms. A third limitation is that we used the GHQ-12 to identify mood disorders, and self-reported questionnaire to identify sleep problems. Detailed mental illness histories and clinical diagnosis were not obtained. Finally, we did not examine the mediating/moderating role of sleep problem in the relationship between work schedule and mood disorders. Statistical models, such as path analysis or structural equation modeling, may be useful in future studies to examine interactions between shift work, sleep, and mood disorders.

In conclusion, an interaction effect between the evening chronotype and shift work on the presence of mood disorders was observed in this study. Evening-chronotype workers were more vulnerable than those with the morning chronotype to shift work exposure regarding mood disorders and sleep problems. Possible mechanisms, including sleep phase changes and melatonin diurnal variations, should be explored in future studies. To improve the mental health of shift workers, the arrangement of shift work schedules should consider their chronotype, and the effect of chronotype-specific strategies aimed at resetting sleep–wake phase on mental health should be examined in future studies.

**Funding source**

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MOST 107-2314-B-039-063-MY3), China Medical University Hospital (grant number DMR-109-247), and NordForsk, the Nordic Program on Health and Welfare (grant numbers 74809, 75021). The funding sources had no role in the writing of the manuscript or the decision to submit it for publication.
References


Facer-Childs ER, Middleton B, Skene DJ, Bagshaw AP. 2019. Resetting the late timing of 'night owls' has a positive impact on mental health and performance. Sleep Med. 60: 236-247. doi:10.1016/j.sleep.2019.05.001


Table 1. Baseline distribution of chronotype, mood disorders, and sleep conditions by work schedule (N = 10 637).

<table>
<thead>
<tr>
<th>Age (y)</th>
<th>Day work (N=4973)</th>
<th>Shift work without night shifts (N=1419)</th>
<th>Shift work with night shifts (N=3997)</th>
<th>Fixed night work (N=248)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤39</td>
<td>1294 (26.02%)</td>
<td>411 (28.96%)</td>
<td>1717 (42.96%)</td>
<td>55 (22.18%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>40-49</td>
<td>1537 (30.91%)</td>
<td>446 (31.43%)</td>
<td>1152 (28.82%)</td>
<td>91 (36.69%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>≥50</td>
<td>2142 (43.07%)</td>
<td>562 (39.61%)</td>
<td>1128 (28.22%)</td>
<td>102 (41.13%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Gender (Women)</td>
<td>4191 (84.28%)</td>
<td>1333 (93.94%)</td>
<td>3633 (90.89%)</td>
<td>221 (89.11%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Chronotype</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Definite morningness</td>
<td>1108 (22.28%)</td>
<td>309 (21.78%)</td>
<td>362 (14.06%)</td>
<td>33 (13.31%)</td>
<td></td>
</tr>
<tr>
<td>Somewhat morningness</td>
<td>1527 (30.71%)</td>
<td>395 (27.84%)</td>
<td>1020 (25.52%)</td>
<td>70 (28.23%)</td>
<td></td>
</tr>
<tr>
<td>Somewhat eveningness</td>
<td>1614 (32.46%)</td>
<td>495 (34.88%)</td>
<td>1477 (36.95%)</td>
<td>76 (30.65%)</td>
<td></td>
</tr>
<tr>
<td>Definite eveningness</td>
<td>724 (14.56%)</td>
<td>220 (15.50%)</td>
<td>938 (23.47%)</td>
<td>69 (27.82%)</td>
<td></td>
</tr>
<tr>
<td>Mood disorders</td>
<td>1054 (21.27%)</td>
<td>319 (22.51%)</td>
<td>815 (20.46%)</td>
<td>54 (21.77%)</td>
<td>0.42</td>
</tr>
<tr>
<td>Difficulty falling asleep</td>
<td>443 (8.91%)</td>
<td>185 (13.04%)</td>
<td>465 (11.63%)</td>
<td>23 (9.27%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Difficulty maintaining asleep</td>
<td>909 (18.28%)</td>
<td>309 (21.78%)</td>
<td>586 (14.66%)</td>
<td>40 (16.13%)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>
Table 2. Odds ratio (OR) and 95% confidence interval (CI) of work schedule (day work as reference) for mood disorders in fixed effects model, stratified by chronotype (N = 10 637).

<table>
<thead>
<tr>
<th></th>
<th>All participants (N=4 264)</th>
<th>Definite morning (N=800)</th>
<th>Somewhat morning (N=1207)</th>
<th>Somewhat evening (N=1427)</th>
<th>Definite Evening (N=830)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR (95%CI)</td>
<td>OR (95%CI)</td>
<td>OR (95%CI)</td>
<td>OR (95%CI)</td>
<td>OR (95%CI)</td>
</tr>
<tr>
<td><strong>Crude model</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shift work without night shifts</td>
<td>1.11 (0.94–1.32)</td>
<td>1.02 (0.71–1.46)</td>
<td>1.01 (0.74–1.37)</td>
<td>1.37 (1.02–1.84)c</td>
<td>1.04 (0.69–1.57)</td>
</tr>
<tr>
<td>Shift work with night shifts</td>
<td>1.21 (1.03–1.43)c</td>
<td>1.03 (0.71–1.49)</td>
<td>1.08 (0.79–1.47)</td>
<td>1.15 (0.87–1.52)</td>
<td>1.90 (1.30–2.78)c</td>
</tr>
<tr>
<td>Fixed night work</td>
<td>1.55 (1.10–2.16)c</td>
<td>1.46 (0.58–3.69)</td>
<td>0.93 (0.42–2.05)</td>
<td>2.01 (1.16–3.49)c</td>
<td>2.01 (1.06–3.82)c</td>
</tr>
<tr>
<td><strong>Adjusted model</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shift work without night shifts</td>
<td>1.08 (0.91–1.28)</td>
<td>0.98 (0.68–1.41)</td>
<td>0.98 (0.72–1.35)</td>
<td>1.35 (1.00–1.83)</td>
<td>1.02 (0.67–1.56)</td>
</tr>
<tr>
<td>Shift work with night shifts</td>
<td>1.12 (0.95–1.32)</td>
<td>0.95 (0.65–1.38)</td>
<td>0.98 (0.72–1.35)</td>
<td>1.11 (0.83–1.47)</td>
<td>1.75 (1.18–2.60)c</td>
</tr>
<tr>
<td>Fixed night work</td>
<td>1.50 (1.06–2.12)c</td>
<td>1.56 (0.60–4.07)</td>
<td>0.87 (0.39–1.93)</td>
<td>1.91 (1.09–3.34)c</td>
<td>2.05 (1.06–3.98)c</td>
</tr>
</tbody>
</table>

aAdjusted for job demands and working hours.
bNumber of participants with a change in the presence of mood disorder between any two waves of the survey.
cp < 0.05
Table 3. Odds ratio (OR) of work schedule (day work as reference) for sleep problems in fixed effects model, stratified by chronotype (N = 10,637).

<table>
<thead>
<tr>
<th>Outcome as difficulty falling asleep</th>
<th>All participants (N&lt;sup&gt;b&lt;/sup&gt; = 1946)</th>
<th>Definite morning (N = 341)</th>
<th>Somewhat morning (N = 513)</th>
<th>Somewhat evening (N = 665)</th>
<th>Definite Evening (N = 427)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR (95%CI)</td>
<td>OR (95%CI)</td>
<td>OR (95%CI)</td>
<td>OR (95%CI)</td>
<td>OR (95%CI)</td>
</tr>
<tr>
<td>Shift work without night shifts</td>
<td>1.32 (1.02–1.69)&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.83 (0.49–1.40)</td>
<td>1.12 (0.70–1.78)</td>
<td>1.81 (1.14–2.87)&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1.68 (0.88–3.22)</td>
</tr>
<tr>
<td>Shift work with night shifts</td>
<td>1.75 (1.36–2.26)&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1.03 (0.57–1.85)</td>
<td>1.05 (0.64–1.73)</td>
<td>2.23 (1.43–3.48)&lt;sup&gt;c&lt;/sup&gt;</td>
<td>3.62 (2.00–6.56)&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Fixed night work</td>
<td>1.56 (0.91–2.67)</td>
<td>2.56 (0.70–9.39)</td>
<td>0.58 (0.13–2.50)</td>
<td>2.50 (0.94–6.62)</td>
<td>1.96 (0.74–5.20)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Outcome as difficulty maintaining asleep</th>
<th>All participants (N = 2974)</th>
<th>Definite morning (N = 649)</th>
<th>Somewhat morning (N = 903)</th>
<th>Somewhat evening (N = 933)</th>
<th>Definite Evening (N = 489)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR (95%CI)</td>
<td>OR (95%CI)</td>
<td>OR (95%CI)</td>
<td>OR (95%CI)</td>
<td>OR (95%CI)</td>
</tr>
<tr>
<td>Shift work without night shifts</td>
<td>0.97 (0.78–1.20)</td>
<td>0.64 (0.41–1.00)</td>
<td>1.26 (0.84–1.89)</td>
<td>1.08 (0.73–1.59)</td>
<td>0.93 (0.52–1.68)</td>
</tr>
<tr>
<td>Shift work with night shifts</td>
<td>1.17 (0.94–1.45)</td>
<td>0.93 (0.57–1.50)</td>
<td>0.94 (0.63–1.40)</td>
<td>1.32 (0.91–1.91)</td>
<td>1.68 (0.97–2.91)</td>
</tr>
<tr>
<td>Fixed night work</td>
<td>1.10 (0.71–1.69)</td>
<td>1.00 (0.32–3.13)</td>
<td>0.42 (0.14–1.21)</td>
<td>2.45 (1.18–5.09)&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.90 (0.38–2.13)</td>
</tr>
</tbody>
</table>

<sup>a</sup> Models were adjusted for working hours and job demands.

<sup>b</sup> Number of participants with a change in the presence of sleep problems between any two waves of the survey.

<sup>c</sup> p < 0.05
Figure 1. Flow chart of study participant selection.

Participated in at least two waves of Hospital Personnel Study 2000-2017
N=22,153

Excluded irregular shift N=109

Employees with work schedules as day work, shift work without night shifts, shift work with night shifts, and fixed night work
N=22,044

Chronotype missing N=11,407

Study sample
N=10,637