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Research Paper

Sleep Quality and Sleepiness among Nursing Shift Workers: A Correlation and Mediation Analysis of Depression, Fatigue, and Attention

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Abstract

Objective: This study investigated the impact of shift work on nurses' sleep quality, sleepiness, fatigue, attention, and depression levels, with findings relevant to healthcare professionals, researchers, and policymakers.

Methods: This cross-sectional questionnaire survey collected basic demographic information and five scales: the Pittsburgh Sleep Quality Index (PSQI), the Karolinska Sleepiness Scale (KSS), the Copenhagen Burnout Inventory (CBI), the Mindful Attention Awareness Scale (MAAS), and the Center for Epidemiologic Studies Depression Scale (CESD). A total of 351 clinical rotating-shift nurses from two regional teaching hospitals and one district hospital in southern Taiwan were recruited through convenience sampling.

Results: Sleep quality was positively correlated with depression, fatigue, and sleepiness, and negatively correlated with attention. Mediation analysis showed that sleep quality was directly associated with depression, fatigue, and attention. After controlling for demographic covariates, the association between sleep quality and sleepiness was statistically explained through fatigue and attention.

Conclusion: Among shift-working nurses, poor sleep quality was not directly associated with sleepiness in this cross-sectional model; rather, the association was statistically explained through both fatigue and attention. To mitigate the harms of shift work, reasonable working hours, health education, thoughtful scheduling, and at least three rest days are recommended.

Keywords: nursing shifts, sleep quality, sleepiness, fatigue, attention, depression, mediation analysis

Introduction

In Taiwan, shift work falls under the regulatory purview of the Ministry of Labor, and several studies have examined how common insufficient sleep and poor sleep quality are among Taiwanese shift workers [1-3]. Night shift workers in particular appear to carry the highest risk of both problems, underscoring how strongly shift work shapes sleep-related outcomes [1, 4].

Shift work is integral to healthcare delivery, particularly in nursing, where continuous patient care is required around the clock [5-8]. Yet it also comes with real costs: shift work has been linked to disrupted circadian rhythms, poorer sleep quality, increased fatigue, and mental health problems such as depression and anxiety [6, 9, 10]. Given these risks, healthcare organizations have a clear incentive to support nurses working non-traditional hours and to prioritize their mental health.

Shift work can give rise to psychosocial stressors that contribute to depression and affect the psychological state and quality of life of health workers [11-13]. Awareness of these issues is crucial to addressing them effectively and ensuring the well-being of healthcare providers, who play a critical role in patient care. For nurses specifically, pinpointing which of these factors drives depression and fatigue could help shape more targeted strategies to protect their mental health [14, 15].

By recognizing these factors, healthcare providers can implement targeted interventions to support the mental health and well-being of nurses working non-traditional hours [16, 17], with downstream benefits for patient care and the broader work environment as well. Despite this growing body of evidence, most prior studies have examined these variables individually or in bivariate associations, without testing the specific pathways through which poor sleep quality translates into greater pre-shift sleepiness. The present study addresses this gap by applying a parallel multiple mediator model to simultaneously test whether depression, fatigue, and attention mediate the cross-sectional association between sleep quality and sleepiness among clinical rotating-shift nurses in Taiwan. Identifying which pathway carries the strongest statistical association can help prioritize occupational health interventions in this population.

Methods

Data collection

A cross-sectional questionnaire survey was conducted to examine the statistical associations among sleep quality, depression, fatigue, attention, and sleepiness in rotating-shift nurses. Data were collected from January to March 2022 at two regional teaching hospitals and one district hospital in southern Taiwan. Questionnaires were distributed by research team members in person at each ward, Monday through Friday, and collected on site after completion before the start of the evening or night shift. A research team member introduced the study purpose and procedures, obtained written informed consent, and collected completed questionnaires. A pilot test with five shift nurses confirmed questionnaire comprehensibility before formal data collection began. All 351 questionnaires distributed were completed and met inclusion criteria, yielding a response rate of 100%.

Sample size was estimated a priori using G*Power based on a regression and correlation framework. Assuming a medium effect size ($f^2 = 0.15$), $\alpha = 0.05$, and statistical power of 0.80, the planned minimum sample size was 270 participants. To allow for potential loss of eligible or complete responses, the target recruitment sample was set at 351 participants. Nurses were eligible if they (1) had been employed for at least six months, (2) had worked at least two night-shift types in the preceding month, and (3) provided written informed consent. Nurses were excluded if they held supervisory positions, were not assigned to rotating shifts, worked in outpatient, operating room, anaesthesia/recovery, psychiatric day ward, or haemodialysis units, performed non-clinical roles, or were taking psychotropic medications other than sleep aids.

Ethics approval

Written informed consent was obtained from all study participants. All procedures were approved and monitored by the Institutional Review Board of Kaohsiung Armed Forces General Hospital (KAFGHIRB 110-010) in accordance with ethical standards and the 1964 Helsinki Declaration.

Study design

This study examined whether the association between sleep quality and sleepiness was statistically explained through depression, fatigue, and attention among shift-working nurses. The research hypotheses are as follows.

- The association between sleep quality and sleepiness among shift-working nurses is statistically explained through depression.
- The association between sleep quality and sleepiness among shift-working nurses is statistically explained through fatigue.
- The association between sleep quality and sleepiness among shift-working nurses is statistically explained through attention.

Research framework

The model of this study included five variables: one independent variable (sleep quality, measured by PSQI [18]), three mediating variables (depression measured by CESD [19], fatigue measured by CBI [20], and attention measured by MAAS [21, 22]), and one

dependent variable (degree of sleepiness, measured by KSS [23]). For the CBI, both the Personal Burnout subscale (5 items assessing general physical and emotional exhaustion) and the Work-related Burnout subscale (5 items assessing exhaustion attributed to work demands) were administered and summed to form the fatigue composite score used in the analyses. The research framework is depicted in Figure 1.

Statistical analysis

Returned questionnaires were screened, and any that were incomplete, ambiguous, or inconsistently answered were excluded. Data were analyzed using IBM SPSS Statistics, version 22.0, which was suited to the research objectives and assumptions. Descriptive statistics were used to summarize the demographic data and main study variables (sleep quality, sleepiness, fatigue, attention, and depression). Regression analysis and correlation tests were used to examine the relationships among variables and to test the proposed hypotheses. Mediation analysis was performed using the PROCESS macro, version 3.5, parallel multiple mediator model (Model 4). Given the cross-sectional design, all analyses examine statistical associations consistent with a mediation model and do not establish temporal precedence or causation. All regression and mediation models controlled for age, marital status, work experience, daily working hours, and commute distance as covariates.

Results

Demographic characteristics of the participants

A total of 351 participants were enrolled in the study. Of these, 333 participants (94.87%) were women. Regarding age, 161 participants (45.87%) were aged 20-29 years, and 98 (27.92%) were aged 30-39 years; together, these two age groups accounted for approximately 74% of the study population. Table 1 summarizes the demographic and occupational characteristics of the participants. Among the participants, 143 (40.74%) were married, and 282 (80.34%) had a college/university education. More than half of the participants, 195 (55.56%), had a commute time of 15 minutes or less, while 240 (68.38%) worked in medical or surgical wards. In terms of clinical experience, 230 participants (65.53%) had ≤10 years of experience. In addition, 216 participants (61.54%) worked ≤9 hours per day.

Correlations among sleep quality, sleepiness, depression, fatigue, and attention

Table 2 shows the correlation matrix for total scores on the PSQI, CESD, CBI, MAAS, and KSS. PSQI scores showed a positive correlation with CESD scores (r = .49, P < .001), CBI scores (r = .42, P < .001), and KSS scores (r = .17, P < .001). CESD scores were positively correlated with CBI scores (r = .62, P < .001) and KSS scores (r = .30, P < .001). CBI scores and KSS scores were also positively correlated (r = .33, P < .001).

In contrast, negative correlations were found between PSQI and MAAS scores (r = -.31, P < .001), CESD and MAAS scores (r = -.55, P < .001), and CBI and MAAS scores (r = -.47, P < .001). MAAS scores and KSS scores were also negatively correlated (r = -.26, P < .001). These results suggest that poorer sleep quality (i.e., a higher PSQI score) was significantly associated with greater depression, fatigue, and sleepiness, and with lower attention.

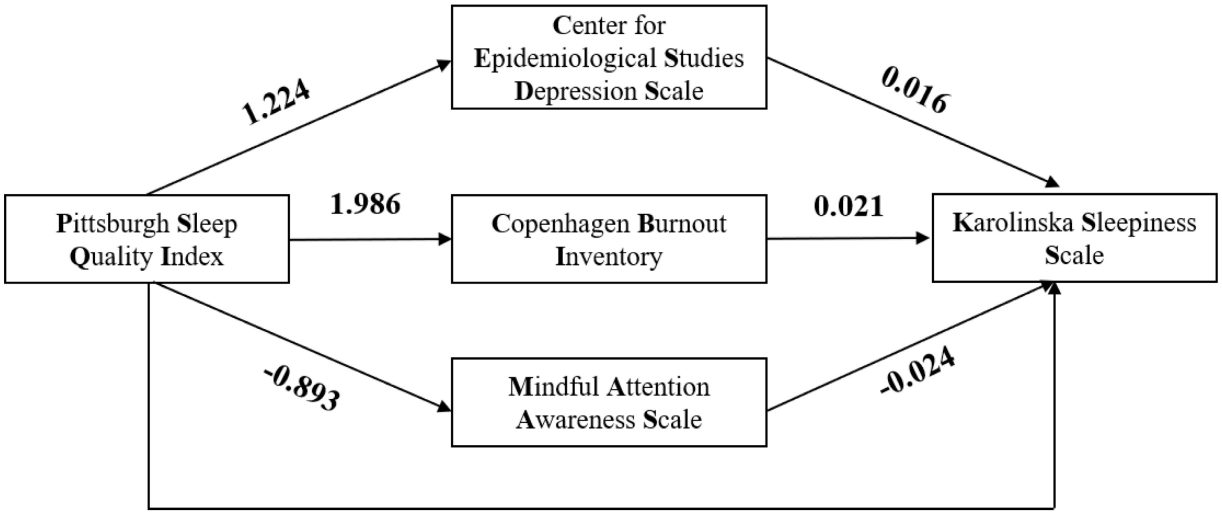


Figure 1. Cross-sectional associations between sleep quality (PSQI) and sleepiness (KSS) through depression (CESD), fatigue (CBI), and attention (MAAS) in shift-working nurses. Path coefficients are unstandardized regression coefficients. The direct path from PSQI to KSS (coeff = 0.034, p = 0.297) was not statistically significant. Standard errors, t-values, and bootstrap 95% confidence intervals for all path coefficients are reported in Table 3.

Table 1. General characteristics of the participants.

Variable	Number of participants (n)	Percentage (%)
Gender		
Men	18	5.13
Women	333	94.87
Age		
20–29 years	161	45.87
30–39 years	98	27.92
≥ 40 years	92	26.21
Marital status		
Unmarried	208	59.26
Married	143	40.74
Education level		
Below college	69	19.66
College/university	282	80.34
Workplace		
Medicine and surgery	240	68.38
Intensive care unit and emergency department	111	31.62
Number of years of work experience		
≤ 10 years	230	65.53
> 10 years	121	34.47
Commute time (min)		
5–15	195	55.56
≥ 16	156	44.44
Daily working (hours)		
≤ 9	216	61.54
> 9	135	38.46

Table 2. Correlation analysis of research variables about sleep quality (PSQI), the mediating variables (CESD, CBI, and MAAS), and the dependent variable (KSS).

	Sample statistic			Pearson correlation				
	N	Mean	Std Dev	PSQI	CESD	CBI	MAAS	KSS
PSQI	351	7.22	3.12	1.00				
CESD	351	14.25	7.63	.49	1.00			
CBI	351	48.4	14.74	.42	.62	1.00		
MAAS	351	70.63	9.52	-.31	-.55	-.47	1.00	
KSS	351	5.08	1.72	.17	.30	.33	-.26	1.00

Cross-sectional associations of sleep quality with sleepiness through depression, fatigue, and attention

Table 3 shows the regression results for the effects of sleep quality (PSQI) on sleepiness (KSS) through depression (CESD), fatigue (CBI), and attention (MAAS). Significant effects were found between the independent variable (PSQI) and CESD, CBI, and MAAS. In addition, the effects of CBI and MAAS on KSS were significant. However, the effects of PSQI and CESD on KSS were nonsignificant, as their 95% CIs contained zero.

For the mediation analysis, we employed a bootstrapping method (with N = 5,000 bootstrap resamples) to test the mediating effects. A mediating effect was considered statistically significant when the 95% confidence interval (CI) did not contain zero. In Table 4, t-values and p-values for indirect effects are provided as supplementary output from PROCESS; the bootstrap 95% CI is the primary inferential criterion, consistent with standard practice for Model 4 mediation reporting.

Cross-sectional indirect associations of sleep quality with sleepiness via depression, fatigue, and attention

Table 4 shows the total, direct, and indirect effects of sleep quality on sleepiness through depression, fatigue, and attention. We employed a bootstrapping method (with N = 5,000 bootstrap resamples) to assess the indirect effects [24]. After controlling for demographic covariates (age, marital status, work experience, daily working hours, and commute distance), indirect effect 2 (PSQI → CBI → KSS) and indirect effect 3 (PSQI → MAAS → KSS) were both significant, as their 95% CIs did not contain zero ([0.011, 0.077] and [0.003, 0.045], respectively). Indirect effect 1 (PSQI → CESD → KSS) was not statistically significant (95% CI: [-0.022, 0.062]).

Table 3. Significant tests of regression coefficients showing the relationships between the independent variable (IV) sleep quality (PSQI), the mediating variables (CESD, CBI, and MAAS), and the dependent variable (KSS).

		Significant test of parameters				Bootstrap 5000 times CI		R^2
		coeff	se	t	p	LLCI	ULCI	
CESD	constant	4.877	1.865	2.614	0.009	1.221	8.533	0.279
	PSQI	**1.224**	**0.115**	**10.614**	**0.000**	**0.998**	**1.450**	
CBI	constant	27.642	3.684	7.503	0.000	20.421	34.862	0.247
	PSQI	**1.986**	**0.228**	**8.721**	**0.000**	**1.540**	**2.433**	
MAAS	constant	77.875	2.591	30.050	0.000	72.795	82.954	0.106
	PSQI	**-0.893**	**0.160**	**-5.575**	**0.000**	**-1.207**	**-0.579**	
KSS	constant	6.018	1.057	5.691	0.000	3.945	8.090	0.171
	PSQI	0.034	0.033	1.046	0.297	-0.030	0.099	
	CESD	0.016	0.016	1.003	0.317	-0.016	0.048	
	CBI	**0.021**	**0.008**	**2.661**	**0.008**	**0.006**	**0.036**	
	MAAS	**-0.024**	**0.011**	**-2.208**	**0.028**	**-0.046**	**-0.003**	

Note: All models control for age, marital status, work experience, daily working hours, and commute distance. Bold = significant ($p < .05$).

Table 4. Significant results for direct and indirect effects between sleep quality (PSQI), the mediating variables (CESD, CBI, and MAAS), and the dependent variable (KSS).

		Effect	BootSE	t	p	BootLLCI	BootULCI
Total effect		0.118	0.029	4.039	**0.000**	0.061	0.175
Indirect effect 1	**PSQI→CESD→KSS**	0.020	0.022	0.927	0.354	-0.022	0.062
Indirect effect 2	**PSQI→CBI→KSS**	0.042	0.017	2.442	**0.015**	**0.011**	**0.077**
Indirect effect 3	**PSQI→MAAS→KSS**	0.022	0.011	2.004	**0.045**	**0.003**	**0.045**
Direct effect	**PSQI→KSS**	0.034	0.033	1.046	0.297	-0.030	0.099

Note: All models control for age, marital status, work experience, daily working hours, and commute distance. Bold = significant.
For indirect effects, significance is determined by the 95% bootstrap CI not containing zero; t and p are provided as supplementary descriptives.

Discussion

Several demographic characteristics were linked to sleep quality, fatigue, attention, depression, and sleepiness among the shift-working nurses in our sample. Nurses with less than a college education, for example, had poorer sleep quality than those with a college degree or higher [25], consistent with reports that better-educated individuals tend to understand and manage their physiological rhythms more effectively. College-educated nurses may also be better equipped to manage the physical and mental toll of their work, which could translate into better sleep. At the same time, nurses with less education may face added stress while still developing their professional skills, and this added stress could itself erode sleep quality [26]. Findings on this point are not entirely consistent, however: other studies report the opposite pattern, with higher education linked to poorer sleep because of greater self-imposed expectations and stress [27, 28].

Married nurses also reported poorer sleep quality than their unmarried colleagues. One possible explanation is that women, who made up the vast majority of this sample, often carry the bulk of family and childcare responsibilities; the resulting burden, compounded by shift work, may take a toll on sleep [26]. The same juggling of family and work demands may also help explain the elevated fatigue and sleepiness seen across this group.

Shift work is known to cause changes in metabolism and personal eating habits, leading to physiological issues such as obesity, diabetes, cardiovascular diseases, and cancer [29, 30]. These changes can reduce quality of life and indirectly contribute to negative emotions and depression.

Commuting distance mattered too: nurses with a commute longer than 15 minutes had poorer sleep quality than those living closer to work, echoing a Swedish study that linked longer commutes to worse sleep [31]. Years of clinical experience told a different story: nurses with fewer than ten years on the job actually slept better than their more senior colleagues, perhaps because growing seniority brings heavier workloads and more complex interpersonal demands that can themselves disrupt sleep [26].

Extended work hours or overtime can lead to sleep problems and poor recovery, resulting in cumulative fatigue [32], partly because the long hours leave little time for leisure, exercise, or family life — all of which can foster negative emotions over time [33]. Taken together, these factors converge in what has been termed shift work disorder — a cluster of poor sleep quality, depression, fatigue, and heightened sleepiness that, together, work against sustained attention [34].

Overall, the cross-sectional mediation model, controlling for age, marital status, work experience,

daily working hours, and commute distance, suggests that the association between sleep quality and sleepiness was explained through both fatigue and attention, but not through depression: although sleep quality was significantly associated with all three mediators, only fatigue (CBI) and attention (MAAS) showed significant associations with sleepiness. These findings are consistent with both fatigue management and attention enhancement being potentially important targets for reducing pre-shift sleepiness among shift-working nurses, though longitudinal studies are needed to confirm directionality. Furthermore, it should be noted that fatigue and sleepiness share considerable operational overlap and may exhibit bidirectional or reciprocal relationships: greater sleepiness can itself exacerbate perceived fatigue, and accumulated fatigue may heighten subsequent sleepiness. The present cross-sectional design cannot disentangle this directionality, and future longitudinal or ecological momentary assessment studies would be better positioned to clarify the temporal sequence between these constructs. More broadly, mitigating the harms of shift work will likely require reasonable working hours, health education, thoughtful scheduling, and at least three rest days. These findings are broadly consistent with prior studies in nursing populations. Cheng et al. similarly reported that burnout mediated the association between shift work disorder and mental health problems among nurses [5]. Consistent with this, Dai et al. found that poor sleep quality was significantly associated with greater depressive symptoms among Chinese night-shift nurses [13]. In the present sample, however, although sleep quality was significantly associated with depression (CESD), the CESD→KSS pathway was not statistically significant, suggesting that the association between sleep quality and sleepiness may be more proximally explained through fatigue and attention rather than through depression.

Limitations

Due to time and manpower constraints, the study utilized a cross-sectional survey and descriptive correlational research design. Convenience sampling was employed to collect data from nursing staff working three shifts at two regional teaching hospitals and one district hospital in southern Taiwan. This design only allows for assessing the relationships between sleep quality, sleepiness, fatigue, attention, and depression at a single point in time, without the capability for long-term, continuous evaluation of these variables at different time points.

The correlational research design used in this study does not establish causal relationships between clinical shift work patterns and sleep quality, sleepiness, fatigue, attention, and depression. The convenience sampling method also raises concerns about the validity of the inferred results, as it may not represent the broader population. Another limitation is the reliance on self-report scales to understand the current status of shift work disorder among clinical nursing staff, which lacks physiological indicators that could enhance the study's validity. Additionally, the KSS was administered immediately before the evening or night shift, capturing pre-shift sleepiness rather than sleepiness experienced during clinical duties. Pre-shift sleepiness may differ from on-shift sleepiness, which is further modulated by circadian nadirs and work demands; readers should interpret the findings in this operational context.

The reliance on convenience sampling within two regional teaching hospitals and one district hospital in southern Taiwan limits the generalizability of these findings. Nurses in different hospital levels, specialties, or geographic regions may differ systematically in their shift work patterns, sleep quality, and fatigue burden. Selection bias is also possible, as nurses who were absent, on leave, or unwilling to participate during data collection are not represented in the sample. Future studies should employ probability-based sampling across a broader range of hospital types and regions to improve representativeness.

As all study variables were assessed using self-report questionnaires administered at a single time point, common method bias is a potential concern. Procedural remedies such as temporal separation of measures were not employed, and statistical checks such as Harman's single-factor test were not conducted. Future studies should consider incorporating objective measures — such as actigraphy for sleep or psychomotor vigilance tasks for attention — to complement self-report instruments.

Conclusion

Both domestic and international studies have confirmed that shift workers are prone to developing shift work disorders, which affect their physical and mental health. Building on this, our model examined how sleep quality relates to depressive emotions, fatigue, attention, and sleepiness among shift-working nurses. In this cross-sectional model, controlling for demographic covariates, sleep quality was not directly associated with sleepiness; rather, its association with sleepiness was statistically explained through both fatigue and attention. Longitudinal studies are needed to determine the temporal direction of these relationships.

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Ethics approval

The study was conducted in accordance with the Declaration of Helsinki, and was approved by the Institutional Review Board of Kaohsiung Armed Forces General Hospital (KAFGHIRB 110-010).

Data availability statement

The data used to support the findings of this study are available from the corresponding author upon reasonable request.

Authorship contribution statement

Chi-Jen Wu: Conceptualization, methodology, software, formal analysis, resources, writing-original draft preparation, writing-review and editing

Kai-Fu Chang: Conceptualization, methodology, software, formal analysis, resources, writing-original draft preparation, writing-review and editing

Hui-Ru Lin: Conceptualization, methodology, software, formal analysis

Yun-Yi Wang: Conceptualization, methodology, software, formal analysis

Chia-Huei Lin: Conceptualization, methodology, software, formal analysis

Hung-Yuan Cheng: Conceptualization, methodology, software, formal analysis

Chung-Bao Hsieh: Conceptualization, methodology

Yung-Kuo Lee: Conceptualization, resources, writing-original draft preparation, writing-review and editing

Bih-O Lee: Conceptualization, writing-review and editing

All authors have read and agreed to the published version of the manuscript.

Declaration of AI and AI-assisted technologies in the writing process

During the preparation of this work, we used AI-assisted technologies to improve the readability and language of the Introduction, Discussion, and Conclusion sections. The AI tool was not used in data analysis, interpretation of results, or generation of scientific conclusions. After using this tool, we reviewed and edited the content as needed and take full responsibility for the content of the publication.

Competing Interests

The authors have declared that no competing interest exists.

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