Nature and Science of Sleep

Elevate Series

Open Access Full Text Article

ORIGINAL RESEARCH

The Relationship Between Poor Sleep and Memory Impairment Among Shift Nurses in China: A Cross-Sectional Study

Lingyu Lin[1,*], Zhuling Gao[2,*], Yanchun Peng[2], Sailan Li[1], Liangwan Chen[1,3], Yanjuan Lin[1,2]

[1]Department of Cardiovascular Surgery, Fujian Medical University Union Hospital, Fuzhou, Fujian Province, 350001, People's Republic of China; [2]Department of Nursing, Fujian Medical University Union Hospital, Fuzhou, Fujian Province, 350001, People's Republic of China; [3]Key Laboratory of Cardio-Thoracic Surgery(Fujian Medical University), Fujian Province University, Fuzhou, Fujian Province, 350001, People's Republic of China

*These authors contributed equally to this work

Correspondence: Yanjuan Lin, Department of Nursing, Fujian Medical University Union Hospital, No. 29 Xinquan Road, Fuzhou, 350001, Fujian Province, People's Republic of China, Tel +86059186218581, Fax +8683344034, Email fjxhyjl@163.com; Liangwan Chen, Department of Cardiovascular Surgery, Fujian Medical University Union Hospital, No. 29 Xinquan Road, Fuzhou, 350001, Fujian Province, People's Republic of China, Fax +86059183301393, Email fjxhlwc@163.com

Purpose: Many shift nurses experience poor sleep quality, and the effect on nurses' cognitive function remains unclear. The study aims to investigate sleep status and explore its association with cognitive function.

Methods: This descriptive cross-sectional study was conducted in a tertiary care hospital in Fujian, China between March and September 2022. By convenience sampling method, 588 shift nurses participated in this study. The Pittsburgh Sleep Quality Index (PSQI) and Bergen Shift Work Sleep Questionnaire (BSWSQ) were used to assess sleep quality, while the Chinese version of Ascertain Dementia-8 (AD-8) was used to evaluate cognitive function. A PSQI score ≤7 is classified as good sleep quality, and a score >7 indicates poor sleep quality. An AD-8 score≥ 2 is considered indicative of memory impairment. Multivariate logistic regression analysis was conducted to explore the association between sleep status and memory impairment.

Results: A total of 310 (52.6%) participants presented poor sleep quality. Among them, 52.2% of participants had day shift-related sleep problems, 45.9% had evening shift-related sleep problems, 61.9% had night shift-related sleep problems, and 15.0% reported rest-day/vacation-related sleep problems. The prevalence of poor sleep quality and each shift-related sleep problem in the memory impairment group were higher than in the normal memory group (P<0.05). Multivariate logistic regression analysis indicated that poor sleep quality (OR=2.073, 95% CI: 1.398~3.072), evening shift-related sleep problems (OR=1.707, 95% CI: 1.028~2.835), night shift-related sleep problems (OR=1.859, 95% CI:1.104~3.129), and rest-day/vacation-related sleep problems (OR=2.069, 95% CI:1.170~3.659) was significantly associated with memory impairment.

Conclusion: This study highlights the prevalence of poor sleep quality among clinical nurses and identifies poor sleep quality and shift-related sleep problems (excluding day shift) as risk factors for memory impairment. Nurse managers should prioritize sleep quality and focus on cognitive function to enhance nurses' occupational health.

Keywords: nurse, sleep disturbance, memory, cognitive function

Introduction

In recent years, with the acceleration of life rhythm and lifestyle change, sleep problems have emerged as a global public health problem. According to the World Health Organization, nearly one-third of the world's population has sleep problems.[1] Sleep problems include dyssomnias that disturb the quality, amount, and timing of sleep, including difficulty falling or staying asleep, and excessive daytime sleepiness.[2,3] Sleep problems can have adverse effects on both physical and mental health, as studies have shown their close association with the development of cardiovascular diseases,[4,5] metabolic disorders,[6] and cancer.[7] Individuals with sleep problems are also at a heightened risk of mental health issues such as depression and anxiety.[8] In addition to the health risks, it is linked to reduced quality of life, lower work productivity, and increased healthcare costs,[9–11] garnering increasing attention.

Received: 16 April 2024
Accepted: 16 September 2024
Published: 18 October 2024

The global population of shift workers is substantial, with approximately 15–30% of employees worldwide engaged in shift work,[12] and the proportion is still increasing. The exposure of nursing staff to shift work is inevitable because hospital nurses need to provide 24-hour direct care for patients. By the end of 2022, the total number of registered nurses in China was 5.20 million.[13] A recent study indicated that the prevalence of poor sleep quality was higher in nurses than in the general population,[14] with a significant 61.0% of nursing staff reporting severe poor sleep quality.[15–18] Another study found that nurses working on shifts tend to have poorer sleep quality compared to nurses who do not work shifts.[19] Poor sleep quality can adversely affect the physical and mental well-being of shift-working nurses. Yeongmi Ha et al found that shift-working nurses with poorer sleep quality are more prone to developing cardiovascular, digestive, and genitourinary diseases.[20] Additionally, studies by Ke-Hsin et al suggest that poor sleep quality can induce depressive symptoms in shift-working nurses, and these depressive symptoms can in turn exacerbate sleep disorders.[21] This question has recently been garnering attention.

Shift work greatly disrupts nurses' sleep patterns, leading to shift work disorder (SWD), which mainly manifests itself as insomnia or excessive sleepiness.[22] The sleep problems they encounter are varied, including difficulty falling asleep, sleep fragmentation, poor sleep quality, and short sleep duration. SWD may be a precipitating factor for insomnia, or exacerbate existing insomnia symptoms. During waking hours, shift workers are prone to excessive sleepiness, impaired cognitive and psychomotor functions, as well as poor emotional regulation.[19,22,23] As cognitive processes are regulated by the endogenous circadian clock, shift work may impair cognitive functioning as well. It disrupts the stable sleep regulatory mechanism and causes desynchronization of circadian rhythms and accumulation of sleep deprivation, and interruptions of these sleep regulatory processes have been proven to lead to decreased cognitive abilities.[24,25] A study investigating the relationship between sleep and daily memory performance among 1275 nurses, showed that sleep deprivation was associated with poorer daily memory performance.[26] Similar studies have also confirmed the link between shift work experience and impaired cognitive function.[27,28] However, other research has suggested that nurses' shift work is almost unrelated to the decline in cognitive abilities.[29] The research findings remain controversial.

Most of the previous studies used scales such as the Pittsburgh Sleep Quality Scale (PSQI) to assess the overall sleep quality of clinical nurses. However, shift-working nurses need to work different shifts, and the assessment results may vary after each shift rotation. Furthermore, the relationship between the overall sleep status and cognitive function among shift nurses remains insufficiently understood. Therefore, this study aims to examine the sleep status (overall sleep quality and each shift-related sleep problem) of shift nurses in a large tertiary general hospital, examining their association with cognitive function, to provide a basis for subsequent interventions.

Materials and Methods

Study Design and Settings

Between March 2022 to September 2022, clinical nurses in a large tertiary hospital in Fujian province, China were recruited using a convenience sampling methodology, and a cross-sectional survey was performed. This research project aims to investigate sleep problems and their correlation with cognitive function among shift nurses.

Study Participants

The shift nurses were included for the following criteria: (a) have a Chinese registered nurse license and (b) be involved in shift work (≥ 1-night shift/month) ≥3 months. The exclusion criteria were as follows: (1) nurses who had not been working full-time for the past month due to any reason (eg, pregnant or lactating) and (2) nurses with physical or mental illnesses (eg, depression or pneumonia).

The sample size was calculated based on the number of independent variables (m) in the logistic regression model. For medium-sized relationships between the independent variables and the dependent or outcome variable, with a 5% significance level and 80% power, the sample size (N) should satisfy the following:[30] $N \geq 10m$ (m= number of independent variables). It is planned to allow up to 16 independent variables in the regression model, and accounting for a 20% attrition rate, the required sample size should be at least 192 for each group.

Measurement

The survey instruments used in the study included a sociodemographic questionnaire, the Pittsburgh Sleep Quality Index (PSQI), the Bergen Shift Work Sleep Questionnaire (BSWSQ), and the Chinese version of the Ascertain Dementia-8 questionnaire (AD-8).

Demographic Characteristics Questionnaire

The demographic characteristics questionnaire was developed by the researchers based on a comprehensive literature review. It encompassed variables such as gender, age, marital status, level of education, years of work, drinking water history, and smoking history.

Pittsburgh Sleep Quality Index

The sleep quality of shift nurses was assessed using the Pittsburgh Sleep Quality Index (PSQI).[31] The PSQI contains 19 items in 7 component domains: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction. Each subscale of the PSQI is scored from 0 to 3, with the total score ranging from 0 to 21; higher scores indicate poorer sleep quality. In China, a PSQI global score greater than 7 points indicates poor sleep, although an original cut-off of 5 points was recommended by the scale developers. The Chinese version of the PSQI has been demonstrated to be valid and reliable in the Chinese population.[32] The PSQI had a Cronbach's alphas coefficient of 0.64 in this sample.

Bergen Shift Work Sleep Questionnaire

Bergen Shift Work Sleep Questionnaire (BSWSQ) was constructed aiming to assess problems with sleep and tiredness/sleepiness across different shifts and during rest days.[33] The questionnaire consisted of 7 questions, each item evaluates the sleep situation during different shifts (day shift, evening shift, night shift) or on rest days. Items I–VI assess sleep-related issues associated with the different shifts, while items I–IV and VII evaluate sleep on rest days. Each item is scored on a 5-point scale from 0 to 4, with higher scores indicating more persistent symptoms. If a symptom is selected as "often" or "always", it indicates a very serious problem. The total score for shift work is 0–24, while the total score for rest days is 0–20. According to the research by Flo et al[34] if at least one of the items I–IV and at least one of the items V–VI is answered as "often" or "always" (for rest days, it is items I–IV and item VII), it indicates the presence of shift-related problems with sleep and tiredness/sleepiness. The BSWSQ results in this study were based on the calculation methods described above.

This study utilized the PSQI to assess the overall sleep quality of shift nurses over the past month, and the BSWSQ scale to evaluate the impact of shift work on sleep.

Overall Cognition Ascertain Dementia-8

The Chinese version of Ascertain Dementia-8 questionnaire was used to evaluate the cognitive function of shift nurses,[35] focusing on the cognitive evaluation of memory. The AD-8 is a brief informant-based measure that has only eight questions, such as domains of judgments, hobby/activity levels, repetitive conversations, learning abilities, memory concerning date/appointments, finance, and daily thought processes. This scale uses a simple question-and-answer format to quickly assess whether a respondent has memory impairments and the resulting decline in their ability to perform daily living activities. Given its relative simplicity and brevity, the AD-8 is particularly suitable for use by non-specialized primary healthcare workers. The AD-8 had a good diagnostic accuracy in discriminating cognitive impairment from normal cognition.[35,36] The total AD-8 score ranges up to 8 points, with scores ≥2 indicating the presence of memory impairment. This scale is easy to operate and has been proven to have comparable validity and accuracy to the Mini-mental State Examination (MMSE).[37]

Data Collection and Ethical Considerations

The study was approved by the hospital ethics committee. Before recruitment, authorization was obtained from the head nurses in each of the clinical departments. Eligible participants were registered nurses employed at a large tertiary hospital in Fujian province. The nurses were informed verbally by the head nurses regarding the survey in advance at

a departmental meeting. The names of the nurses who were willing to participate in the research were collected by the head nurses and forwarded to the research team. Using scripted instructions (including the unified greeting, self-introduction, and survey procedure), the research team subsequently contacted the volunteers in a department meeting room. The nurses were provided with an information sheet explaining the purpose of the survey and instructions on how to complete the questionnaire. The volunteer nurses were assured that the survey was anonymous and confidential and that they could withdraw at any time without consequences. All nurses who agreed to participate signed an informed consent form. Subsequently, the research team distributed the questionnaires to the participating nurses in a department meeting room. Data collectors checked the completed questionnaires on the spot.

Data Analysis

Epidata 3.1 software was used for data entry, and SPSS 25.0 was employed for statistical analysis. The demographic characteristics and sleep status of shift nurses prescribed normal memory and memory impairment were compared using bivariate analysis.

For the bivariate analysis, comparisons were conducted using the independent *t*-test for continuous variables (for example, PSQI scores) and the chi-square test or Fisher's exact test for categorical variables (such as gender, education level, and marital status). Subsequently, associations between cognitive function and sleep status were examined using logistic regression models. The results were described with odds ratios (OR) and their 95% confidence intervals (CI). In the bivariate analysis, variables with P-value < 0.25 were included in the multivariable logistic regression. All tests were two-sided, with $P<0.05$ considered statistically significant.

Results

Characteristics of Participants

A total of 700 questionnaires were distributed; 632 questionnaires were returned (response rate: 90.3%), and 44 invalid questionnaires (with missing information or incomplete questionnaires) were excluded, representing an effective response rate of 93.0%. At last, 588 questionnaires were included in the final analysis. The descriptive characteristics of the study subjects are displayed in Table 1. The average age of the shift nurses was (31.34±6.49) years, with the majority being female (95.9%). Most of the shift nurses were married (57.1%), senior nurses (57.7%), and had a college

Table 1 The Characteristics of Shift Nurses by Memory Function [n (%)]

Variables	Total (n=588)	Memory Impairment (AD-8 sore>2)		X^2	P-value
		No (n=335)	Yes (n=253)		
Sex				0.019	0.891
Male	24 (4.1)	14 (4.2)	10 (4.0)		
Female	564 (95.9)	321 (95.8)	243 (96.0)		
Age (year)				3.934	0.140
<30	294 (50.0)	179 (53.4)	115 (45.5)		
30–40	238 (40.5)	128 (38.2)	110 (43.5)		
>40	56 (9.5)	28 (8.4)	28 (11.1)		
Marital status				–	0.066*
Unmarried	245 (41.7)	153 (45.7)	92 (36.4)		
Married	336 (57.1)	179 (53.4)	157 (62.1)		
Widowed/divorced	7 (1.2)	3 (0.9)	4 (1.6)		
Level of education				6.142	0.046
Technical secondary school	6 (1.0)	5 (1.5)	1 (0.4)		
College	329 (56.0)	199 (59.4)	130 (51.4)		
University	253 (43.0)	131 (39.1)	122 (48.2)		

(*Continued*)

Table 1 (Continued).

Variables	Total (n=588)	Memory Impairment (AD-8 sore>2)		X^2	P-value
		No (n=335)	Yes (n=253)		
Technical title				13.754	0.001
Nurse	187 (31.8)	127 (37.9)	60 (23.7)		
Senior nurse	339 (57.7)	178 (53.1)	161 (63.6)		
Nurse-in-charge and above	62 (10.5)	30 (9.0)	32 (12.6)		
Years of work (year)				7.410	0.025
<10	373 (63.4)	228 (68.1)	145 (57.3)		
10–20	172 (29.3)	87 (26.0)	85 (33.6)		
>20	43 (7.3)	20 (6.0)	23 (9.1)		
Frequency of night shift (per week)				14.754	<0.001
<2	379 (64.5)	238 (71.0)	141 (55.7)		
≥2	209 (35.5)	97 (29.0)	112 (44.3)		
Having children				7.946	0.005
Yes	300 (51.0)	154 (46.0)	146 (57.7)		
No	288 (49.0)	181 (54.0)	107 (42.3)		
Smoking history				–	0.751*
Yes	8 (1.4)	5 (1.5)	3 (1.2)		
No	580 (98.6)	330 (98.5)	250 (98.8)		
Drinking history				0.000	0.987
Yes	21 (3.6)	12 (3.6)	9 (3.6)		
No	567 (96.4)	323 (96.4)	244 (96.4)		
Sleeping aid use				0.186	0.666
Yes	75 (12.8)	41 (12.2)	34 (13.4)		
No	513 (87.2)	294 (87.8)	219 (86.6)		

Note: *Fisher's exact test.

education (56.0%). Among the participants, 373 shift nurses (63.4%) had less than 10 years of work experience, 172 shift nurses (29.3%) had worked between 10–20 years, and 43 shift nurses (7.3%) had over 20 years of experience. Most of them (64.5%) were working less than 2 times night shifts per week. The AD-8 results indicated that 43.0% of the shift nurses were in the memory impairment group. No statistically significant differences were found between the groups in terms of age, gender, marital status, or use of sleeping aids (P>0.05).

Characteristics of Sleep Disturbance of Participants

The participants had a mean PSQI score of 8.20±2.99, with 309 shift nurses (52.6%) scoring >7 on the PSQI. The average scores of all dimensions of PSQI in the memory impairment group were significantly higher than those in the normal memory group. Statistically significant differences were observed between the two groups in terms of subjective sleep quality, sleep duration, sleep disturbances, use of sleep medication, and daytime dysfunction components of the PSQI (P<0.05, see Table 2). In terms of shift-related problems with sleep and tiredness/sleepiness, 307 shift nurses (52.2%) had day shift-related sleep problems, 270 (45.9%) had evening shift-related sleep problems, 364 (61.9%) had night shift-related sleep problems, and 88 shift nurses (15.0%) reported rest-day/vacation-related sleep problems. The prevalence of each shift-related sleep problem was significantly higher in the memory impairment group compared to those with normal memory function (all P<0.05, see Table 2).

Multivariate Logistic Regression of Sleep Status and Memory Impairment

A binary logistic regression analysis was conducted with cognitive function (0=normal memory function, 1=memory impairment) as the dependent variable, and level of education, technical title, years of work (year), frequency of night shift (per week), having children, sleep quality and each shift-related sleep problems as covariates, using the forward

Table 2 Comparison of Each Dimension of the PSQI Scale and BSWSQ Scale Between Normal Memory Group and Memory Impairment Group (X±S/n (%))

Variables	Total (n=588)	Normal Memory Group (n=335)	Memory Impairment Group (n=253)	t/X^2	P-value
PSQI scale					
Total PSQI score	8.20±2.99	7.44±2.67	9.21±3.10	−7.457	<0.001
Subjective sleep quality	1.42±0.66	1.29±0.62	1.59±0.69	−5.621	<0.001
Sleep latency	2.10±0.74	2.06±0.76	2.16±0.71	−1.716	0.087
Sleep duration	0.80±0.78	0.73±0.76	0.89±0.80	−2.598	0.010
Habitual sleep efficiency	0.46±0.81	0.43±0.80	0.51±0.82	−1.288	0.198
Sleep disturbances	1.37±0.55	1.25±0.47	1.53±0.61	−6.178	<0.001
Use of sleep medication	0.30±0.73	0.21±0.62	0.41±0.85	−3.239	0.001
Daytime dysfunction	1.75±0.90	1.47±0.88	2.11±0.79	−9.149	<0.001
Sleep quality				42.418	<0.001
Good (PSQI≤7)	279 (47.4)	198 (59.1)	81 (32.0)		
Poor (PSQI>7)	309 (52.6)	137 (40.9)	172 (68.0)		
BSWSQ scale					
Day shift-related problems with sleep and tiredness/sleepiness	307 (52.2)	152 (45.4)	155 (61.3)	14.589	<0.001
Evening shift-related problems with sleep and tiredness/sleepiness	270 (45.9)	110 (32.8)	160 (63.2)	53.660	<0.001
Night shift-related problems with sleep and tiredness/sleepiness	364 (61.9)	166 (49.6)	198 (78.3)	50.375	<0.001
Rest-day/vacation-related problems with sleep and tiredness/sleepiness	88 (15.0)	26 (7.8)	62 (24.5)	31.758	<0.001

conditional method. Collinearity diagnostics showed that the largest value of the variance inflation factor (VIF) was 3.871, suggesting that there was no obvious collinearity. Logistic regression showed that nurses with poor sleep quality had an almost two-fold higher risk of suffering memory impairment than those with good sleep quality (OR=2.073,95% CI:1.398~3.072). Furthermore, when compared to nurses without shift-related sleep problems, those with evening shift-related sleep problems (OR=1.707, 95% CI:1.028~2.835), night shift-related sleep problems (OR=1.859, 95% CI:1.104~3.129), and rest-day/vacation-related sleep problems (OR=2.069, 95% CI:1.170~3.659) were at a higher risk of memory impairment (Table 3).

Table 3 Logistic Regression Analysis for Risk Factors Associated with Memory Impairment

Variables	B	SE	Wald χ^2	OR	95%CI	P-value
Age (year)						
<30				1		
30-40	-0.526	0.337	2.445	0.591	(0.306, 1.143)	0.118
>40	-0.679	0.607	1.251	0.507	(0.154, 1.667)	0.263
Marital status						
Unmarried				1		
Married	-0.071	0.382	0.034	0.931	(0.440, 1.971)	0.853
Widowed/divorced	0.141	0.897	0.025	1.151	(0.199, 6.673)	0.875
Level of education						
Technical secondary school				1		
College	1.362	1.179	1.335	3.905	(0.387, 39.366)	0.387
University	1.441	1.189	1.469	4.225	(0.411, 43.438)	0.411

(*Continued*)

Table 3 (Continued).

Variables	B	SE	Wald χ^2	OR	95%CI	P-value
Technical title						
Nurse				1		
Senior nurse	0.447	0.281	1.093	1.563	(0.902, 2.709)	0.112
Nurse-in-charge and above	0.483	0.462	1.109	1.620	(0.656, 4.005)	0.296
Years of work (year)						
<10				1		
10-20	0.252	0.315	0.638	1.286	(0.693, 2.385)	0.425
>20	0.311	0.639	0.238	1.365	(0.390, 4.773)	0.626
Frequency of night shift (per week)						
<2				1		
≥2	0.741	0.195	14.396	2.099	(1.431, 3.079)	<0.001
Having children						
Yes				1		
No	-0.403	0.383	1.109	0.668	(0.315, 1.416)	0.292
Sleep quality						
Good (PSQI≤7)				1		
Poor (PSQI>7)	0.729	0.201	13.169	2.073	(1.398, 3.072)	<0.001
Day shift-related problems with sleep and tiredness/sleepiness						
No				1		
Yes	-0.242	0.214	1.277	0.785	(0.516, 1.195)	0.258
Evening shift-related problems with sleep and tiredness/sleepiness						
No				1		
Yes	0.535	0.259	4.273	1.707	(1.028, 2.835)	0.039
Night shift-related problems with sleep and tiredness/sleepiness						
No				1		
Yes	0.620	0.266	5.443	1.859	(1.104, 3.129)	0.020
Rest-day/vacation-related problems with sleep and tiredness/sleepiness						
No				1		
Yes	0.727	0.291	6.245	2.069	(1.170, 3.659)	0.012

For the logistic regression analysis, the omnibus model was statistically significant ($p<0.001$), $\chi 2$ (df=13)=112.840. The fitness of the logistic regression model was shown by the Hosmer–Lemeshow goodness-of-fit test, which resulted in a Chi-square of 4.467; df=8; p=0.813. The fitness was also shown by the two measures of predictive power: Cox and Snell $R^2 = 0.175$, and Nagelkerke's $R^2=0.234$.

Discussion

The nursing occupation is characterized by high work intensity and heavy workload. In China, the policy states that nurses have five working days per week, and each day's work is 8 hours. Most clinical nurses work in 8-hour or 12-hour shifts, rotating between day shifts, evening shifts, and night shifts or day shifts and night shifts. In a study by Liuyan et al, 333 (63.3%) nurses worked more than 50 hours per week, of which 148 (28.1%) nurses worked more than 60 hours, and more than 50% of nurses earned less than 7000 yuan per month. As the patient-centered nursing concept is updated, patients' self-protection awareness is constantly enhanced, and the requirements for nursing work are becoming increasingly stringent, the psychological and physical burden on nurses is becoming increasingly heavy. Clinical nurses are increasingly experiencing physical symptoms such as insomnia and headaches.

In this study, we explored the current status of sleep quality, shift-related sleep problems, and cognitive function (focusing on memory function) among shift nurses through a cross-sectional survey, to further explore the relationship between sleep and memory impairment. Our findings revealed that the shift nurses exhibited poor sleep quality, with a notable prevalence of shift-related sleep problems. Multivariate logistic regression analyses indicated that poor sleep

quality and encountering evening shift-related sleep problems, night shift-related sleep problems, and rest-day/vacation-related sleep problems were significant risk factors for memory impairment in shift nurses. The study underscores the widespread presence of sleep problems among shift nurses, emphasizing the need for effective prevention and intervention strategies to enhance their sleep quality and positively impact memory function.

In our study, we utilized the PSQI to subjectively assess the sleep quality of shift nurses. The prevalence of poor sleep quality (PSQI>7) among shift nurses was 52.6%, slightly lower than the rates reported among Jordanian nurses (68.0%),[38] and by Park et al in South Korea (79.8%).[39] The data demonstrated that shift nurses predominantly experienced subjective poor sleep quality, long sleep latency, sleep disturbances, and daytime functional impairment, likely attributed to circadian rhythm disturbances induced by night and shift work. Currently, extremely few studies have explored the impact of different shifts on sleep, with the BSWSQ scale being the sole tool available for assessing problems with sleep and tiredness/sleepiness across different shifts and during rest days. Our study innovatively investigated the prevalence of shift-related sleep problems using the BSWSQ scale. The results showed a high prevalence of shift-related sleep problems among shift nurses, with 52.2% reporting mild day shift-related sleep problems, 45.9% reporting evening shift-related sleep problems, 61.9% reporting night shift-related sleep problems, and 15.0% reporting rest-day/vacation-related sleep problems. Apart from night shift-related sleep problems, the prevalence of other shift-related sleep problems was higher than reported in another Norway study.[34] Cognitive function was assessed using the AD-8 in our study, a tool capable of detecting memory impairment. We found that 43.0% of participants exhibited memory impairment, significantly higher than the rate observed among 920 retired nurses.[40] These differences are probably due to differences in the study populations, and geographical discrepancies.

In the present study, we observed that poor sleep quality and shift-related sleep problems (except day shift) were associated with increased odds of memory impairment in shift nurses. Similar to our results, Kaliyaperumal et al reported that poor sleep quality might be a result of decreased cognitive function.[41] The difference was that the Epworth Sleepiness Scale was used to evaluate sleep quality in their study. The underlying biological mechanisms by which shift work sleep disorders affect memory impairment remain unclear. Based on the literature, we speculated several possibilities. Firstly, shift work often entails overnight work, incurring acute circadian misalignment. Circadian rhythm is linked to the clearance of brain amyloid-β protein, and poor sleep quality has been shown to disrupt the accumulation and clearance of β-amyloid (Aβ).[42] Aβ deposition can significantly affect neuronal health and potentially lead to neurodegeneration. In addition, it can disrupt human non-rapid eye movement (NREM) slow waves and related hippocampus-dependent memory consolidation.[43] In general, shift work lowers the quality of sleep compared to daytime work. Previous studies have shown that poor sleep quality was associated with reduced volume within the right prefrontal cortex,[44] an area involved in a range of cognitive functions, such as attention, memory, and executive functions. In this study, we hypothesize that the poor sleep quality of shift nurses may have a detrimental impact on the functioning of the prefrontal cortex, thereby impairing memory function.[45]

Furthermore, evening and night shift-related sleep problems can cause severe disturbances in nurse's circadian rhythm, in which the brain cannot get adequate rest. Studies comparing functional brain imaging findings between sleep-deprived and well-rested brains have consistently found decreases in working memory in the sleep-deprived brain.[46] Nurses repeatedly experience this sleep disturbance during extended and repetitive shifts. Chronic sleep deprivation has been shown to affect neurobehavioral function and induce changes in brain metabolism.[47,48] Meanwhile, fatigue or insufficient recovery from fatigue caused by sleep disturbance during evening and night shifts will accelerate the rate of cognitive decline and increase the likelihood of developing memory impairment. It should be noted that the deterioration in cognitive function due to nurses' lack of sleep is not a one-off change. Above of them are just our speculation, the precise mechanism requires further investigations.

Based on our results, measures to improve sleep quality for shift nurses are necessary. Firstly, it is suggested that departments should establish a flexible scheduling system and shift rotation policy. Currently, most hospitals in China predominantly adopts a rapid shift rotation schedule for nurses, whereby they alternate between day and night shifts within a week. A previous study has suggested that the direction of a rapid shift rotation schedule in hospital nurses harms the sleep quantity and quality.[49] This schedule can easily disrupt the circadian rhythm and lead to sleep disorders. Nursing managers should reduce the frequency of shift rotations when scheduling, gradually transitioning from the rapid rotation system to a slower rotation system or a forward-rotating schedule, to promote the synchronization of nurses'

sleep-wake cycles. Shift nurses can be allowed to take a 2–3 hour nap during night shifts to improve cognitive function and psychomotor vigilance, mitigating the impact of the work schedule on their sleep. Daytime 20–30 minute naps during day shifts can also be beneficial for improving nurses' sleep quality. In addition, shift nurses should also reduce the time spent on electronic media before bedtime, and adopt healthy dietary habits by limiting caffeine and alcohol intake, to improve their overall sleep quality.

There are a few limitations to the current study. First, the study used a cross-sectional design and self-reported measures; common method bias might thus inflate the observed relationships between variables. Second, the measurement of sleep status was based on only self-report without additional objective assessment, potentially introducing recall bias. In future research, we will use more practical objective sleep measurement methods, such as actigraphy measurements, to obtain not only objective but also prolonged assessments of sleep over several days or weeks. Third, the assessment of cognitive function in this study was limited to the AD-8 test. Future analyses must use a more objective assessment of cognitive function (eg the multimodal MRI measures), focusing on specific domains such as executive function, processing speed, attention, and working memory. Alongside this, longitudinal studies investigating whether the negative impact of shift work on cognition is mediated by sleep should be prioritized in future studies. Furthermore, despite adjusting for the confounding variables in our study, residual confounding due to unknown or unmeasured confounders cannot be excluded. Several factors, such as physical activity, dietary habits, and emotional stress could have a significant influence on cognitive function. Further prospective studies with large sample sizes are now needed to identify the underlying mechanisms of this relationship.

Conclusion

This study appears to be the first survey concerning sleep and its association with the cognitive function of shift nurses in China. The findings indicate that shift nurses have poor sleep quality and a high prevalence of shift-related sleep problems, with both poor sleep quality and shift-related sleep problems (except day shifts) identified as risk factors for memory impairment. Interventions aimed at enhancing the sleep quality of shift nurses, at both individual and managerial levels, are essential to enhance the cognitive function of nurses.

Implications for Nursing Management

Shift work implies a significant amount of sleep deprivation, which often results in circadian rhythm disturbances and memory impairment. Nursing managers should pay attention to nurses' sleep quality, as improving sleep quality can positively impact memory performance.

Abbreviations

PSQI, Pittsburgh Sleep Quality Index; BSWSQ, Bergen Shift Work Sleep Questionnaire; MMSE, Mini-mental State Examination; VIF, variance inflation factor; NREM, Non-rapid Eye Movement.

Ethics Approval and Informed Consent

All procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional committee and with the 1964 helsinki declaration and its later amendments or comparable ethical standards. Ethics approval was provided by the ethics committee of Union Hospital of Fujian Medical University (2021KY107) and all written informed consents were signed by nurses.

Data Sharing Statement

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Acknowledgments

Yanjuan Lin and Liangwan Chen are co-corresponding authors for this study. Lingyu Lin and Zhuling Gao are co-first authors for this study. The authors would like to acknowledge the nurses who participated in this study.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Funding

This project was funded by the Joint Funds for the innovation of science and technology, Fujian province(2021Y9062).

Disclosure

The authors declare that they have no competing interests in this work.

References

1. Ohayon MM, Paskow M, Roach A, et al. The national sleep foundation's sleep satisfaction tool. *Sleep Health*. 2019;5(1):5–11. doi:10.1016/j.sleh.2018.10.003
2. Sateia MJ. International classification of sleep disorders-third edition: highlights and modifications. *Chest*. 2014;146(5):1387–1394. doi:10.1378/chest.14-0970
3. Ferrie JE, Kumari M, Salo P, Singh-Manoux A, Kivimäki M. Sleep epidemiology--A rapidly growing field. *Int J Epidemiol*. 2011;40(6):1431–1437. doi:10.1093/ije/dyr203
4. Yan LJ, Xie YJ. Associations between sleep quality and 10-year cardiovascular disease risk among female nurses in hong kong: a cross-sectional study. *J Cardiovascul Nurs*. 2022;37(3):E22–e31. doi:10.1097/JCN.0000000000000857
5. Cappuccio FP, Cooper D, D'Elia L, Strazzullo P, Miller MA. Sleep duration predicts cardiovascular outcomes: a systematic review and meta-analysis of prospective studies. *Eur Heart J*. 2011;32(12):1484–1492. doi:10.1093/eurheartj/ehr007
6. Schmid SM, Hallschmid M, Schultes B. The metabolic burden of sleep loss. *Lancet Diabetes Endocrinol*. 2015;3(1):52–62. doi:10.1016/S2213-8587(14)70012-9
7. Mogavero MP, DelRosso LM, Fanfulla F, Bruni O, Ferri R. Sleep disorders and cancer: state of the art and future perspectives. *Sleep Med Rev*. 2021;56:101409.
8. Clement-Carbonell V, Portilla-Tamarit I, Rubio-Aparicio M, Madrid-Valero JJ. Sleep quality, mental and physical health: a differential relationship. *Int J Environ Res Public Health*. 2021;18(2):460. doi:10.3390/ijerph18020460
9. Szentkirályi A, Madarász CZ, Novák M. Sleep disorders: impact on daytime functioning and quality of life. *Expert Rev Pharmacoecon Outcomes Res*. 2009;9(1):49–64. doi:10.1586/14737167.9.1.49
10. Lian Y, Xiao J, Liu Y, et al. Associations between insomnia, sleep duration and poor work ability. *J Psychosom Res*. 2015;78(1):45–51. doi:10.1016/j.jpsychores.2014.09.009
11. Jasani FS, Seixas AA, Madondo K, Li Y, Jean-Louis G, Pagán JA. Sleep duration and health care expenditures in the United States. *Med Care*. 2020;58(9):770–777. doi:10.1097/MLR.0000000000001351
12. Boivin DB, Boudreau P. Impacts of shift work on sleep and circadian rhythms. *Pathol Biol*. 2014;62(5):292–301. doi:10.1016/j.patbio.2014.08.001
13. National Bureau of Statistics. Statistical Bulletin on National Economic and Social Development of the People's Republic of China in 2022 [EB/OL] (2023-02-28). Available from: http://www.stats.gov.cn/sj/zxfb/202302/t20230228_1919011.html. Accessed October 01, 2024.
14. Shao MF, Chou YC, Yeh MY, Tzeng WC. Sleep quality and quality of life in female shift-working nurses. *J Adv Nurs*. 2010;66(7):1565–1572. doi:10.1111/j.1365-2648.2010.05300.x
15. Zeng LN, Yang Y, Wang C, et al. Prevalence of poor sleep quality in nursing staff: a meta-analysis of observational studies. *Behav Sleep Med*. 2020;18(6):746–759. doi:10.1080/15402002.2019.1677233
16. Li L, Wang YY, Wang SB, et al. Prevalence of sleep disturbances in Chinese university students: a comprehensive meta-analysis. *Journal of Sleep Research*. 2018;27(3):e12648. doi:10.1111/jsr.12648
17. Lu L, Wang SB, Rao W, et al. The prevalence of sleep disturbances and sleep quality in older Chinese adults: a comprehensive meta-analysis. *Behav Sleep Med*. 2019;17(6):683–697. doi:10.1080/15402002.2018.1469492
18. Liu H, Liu J, Chen M, et al. Sleep problems of healthcare workers in tertiary hospital and influencing factors identified through a multilevel analysis: a cross-sectional study in China. *BMJ Open*. 2019;9(12):e032239. doi:10.1136/bmjopen-2019-032239
19. Sun Q, Ji X, Zhou W, Liu J. Sleep problems in shift nurses: a brief review and recommendations at both individual and institutional levels. *J Nurs Manag*. 2019;27(1):10–18. doi:10.1111/jonm.12656
20. Ha Y, Lee SH, Lee DH, Kang YH, Choi W, An J. Effectiveness of a mobile wellness program for nurses with rotating shifts during COVID-19 pandemic: a pilot cluster-randomized trial. *Int J Environ Res Public Health*. 2022;19(2):1014. doi:10.3390/ijerph19021014
21. Chueh K-H, Chen K-R, Lin Y-H. Psychological distress and sleep disturbance among female nurses: anxiety or depression? *J Transcult Nurs*. 2021;32(1):14–20. doi:10.1177/1043659619881491
22. Wright KP, Bogan RK, Wyatt JK. Shift work and the assessment and management of shift work disorder (SWD). *Sleep Med Rev*. 2013;17(1):41–54. doi:10.1016/j.smrv.2012.02.002
23. Rosa D, Terzoni S, Dellafiore F, Destrebecq A. Systematic review of shift work and nurses' health. *Occupat Med*. 2019;69(4):237–243. doi:10.1093/occmed/kqz063
24. Zion N, Shochat T. Cognitive functioning of female nurses during the night shift: the impact of age, clock time, time awake and subjective sleepiness. *Chronobiol Int*. 2018;35(11):1595–1607. doi:10.1080/07420528.2018.1497642

25. Bhat A, Pires AS, Tan V, Babu Chidambaram S, Guillemin GJ. Effects of sleep deprivation on the tryptophan metabolism. *Int J Tryptophan Res*. 2020;13:1178646920970902. doi:10.1177/1178646920970902
26. Thun E, Waage S, Bjorvatn B, et al. Short sleep duration and high exposure to quick returns are associated with impaired everyday memory in shift workers. *Nurs Outlook*. 2021;69(3):293–301. doi:10.1016/j.outlook.2020.09.008
27. Titova OE, Lindberg E, Elmståhl S, Lind L, Schiöth HB, Benedict C. Association between shift work history and performance on the trail making test in middle-aged and elderly humans: the EpiHealth study. *Neurobiol Aging*. 2016;45:23–29. doi:10.1016/j.neurobiolaging.2016.05.007
28. Marquié JC, Tucker P, Folkard S, Gentil C, Ansiau D. Chronic effects of shift work on cognition: findings from the VISAT longitudinal study. *Occup Environ Med*. 2015;72(4):258–264. doi:10.1136/oemed-2013-101993
29. Devore EE, Grodstein F, Schernhammer ES. Shift work and cognition in the nurses' health study. *Am J Epidemiol*. 2013;178(8):1296–1300. doi:10.1093/aje/kwt214
30. Peduzzi P, Concato J, Kemper E, Holford TR, Feinstein AR. A simulation study of the number of events per variable in logistic regression analysis. *J Clin Epidemiol*. 1996;49(12):1373–1379. doi:10.1016/S0895-4356(96)00236-3
31. Buysse DJ, Reynolds CF, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh sleep quality index: a new instrument for psychiatric practice and research. *Psychiatry Res*. 1989;28(2):193–213. doi:10.1016/0165-1781(89)90047-4
32. Liu X. Reliability and validity of the Pittsburgh Sleep Quality Index. *Chin J Psychiatry*. 1996;02:103–107.
33. Flo E, Bjorvatn B, Folkard S, et al. A reliability and validity study of the Bergen shift work sleep questionnaire in nurses working three-shift rotations. *Chronobiol Int*. 2012;29(7):937–946. doi:10.3109/07420528.2012.699120
34. Flo E, Pallesen S, Åkerstedt T, et al. Shift-related sleep problems vary according to work schedule. *Occup Environ Med*. 2013;70(4):238–245. doi:10.1136/oemed-2012-101091
35. Chen HH, Sun FJ, Yeh TL, et al. The diagnostic accuracy of the Ascertain Dementia 8 questionnaire for detecting cognitive impairment in primary care in the community, clinics and hospitals: a systematic review and meta-analysis. *Fam Pract*. 2018;35(3):239–246. doi:10.1093/fampra/cmx098
36. Galvin JE, Roe CM, Xiong C, Morris JC. Validity and reliability of the AD8 informant interview in dementia. *Neurology*. 2006;67(11):1942–1948. doi:10.1212/01.wnl.0000247042.15547.eb
37. Mao HF, Chang LH, Tsai AY, et al. Diagnostic accuracy of Instrumental Activities of Daily Living for dementia in community-dwelling older adults. *Age Ageing*. 2018;47(4):551–557. doi:10.1093/ageing/afy021
38. Almhdawi KA, Alrabbaie H, Obeidat DS, et al. Sleep quality and its predictors among hospital-based nurses: a cross-sectional study. *Sleep Breath*. 2021;25(4):2269–2275. doi:10.1007/s11325-021-02333-z
39. Park E, Lee HY, Park CS. Association between sleep quality and nurse productivity among Korean clinical nurses. *J Nurs Manag*. 2018;26(8):1051–1058. doi:10.1111/jonm.12634
40. Gan J, Wang XD, Shi Z, et al. The impact of rotating night shift work and daytime recharge on cognitive performance among retired nurses. *Front Aging Neurosci*. 2021;13:827772. doi:10.3389/fnagi.2021.827772
41. Kaliyaperumal D, Elango Y, Alagesan M, Santhanakrishanan I. Effects of sleep deprivation on the cognitive performance of nurses working in shift. *J Clin Diagn Res*. 2017;11(8):Cc01–cc03. doi:10.7860/JCDR/2017/26029.10324
42. Lucey BP, Mawuenyega KG, Patterson BW, et al. Associations between β-amyloid kinetics and the β-amyloid diurnal pattern in the central nervous system. *JAMA neurol*. 2017;74(2):207–215. doi:10.1001/jamaneurol.2016.4202
43. Raven F, der Zee EA V, Meerlo P, Havekes R. The role of sleep in regulating structural plasticity and synaptic strength: implications for memory and cognitive function. *Sleep Med Rev*. 2018;39:3–11. doi:10.1016/j.smrv.2017.05.002
44. Sexton CE, Storsve AB, Walhovd KB, Johansen-Berg H, Fjell AM. Poor sleep quality is associated with increased cortical atrophy in community-dwelling adults. *Neurology*. 2014;83(11):967–973. doi:10.1212/WNL.0000000000000774
45. Mystakidou K, Tsilika E, Parpa E, Katsouda E, Galanos A, Vlahos L. Psychological distress of patients with advanced cancer: influence and contribution of pain severity and pain interference. *Cancer Nursing*. 2006;29(5):400–405. doi:10.1097/00002820-200609000-00009
46. Chee MW, Chuah LY. Functional neuroimaging insights into how sleep and sleep deprivation affect memory and cognition. *Curr Opin Neurol*. 2008;21(4):417–423. doi:10.1097/WCO.0b013e3283052cf7
47. Kondratova AA, Kondratov RV. The circadian clock and pathology of the ageing brain. *Nat Rev Neurosci*. 2012;13(5):325–335. doi:10.1038/nrn3208
48. Basner M, Rao H, Goel N, Dinges DF. Sleep deprivation and neurobehavioral dynamics. *Curr Opin Neurobiol*. 2013;23(5):854–863. doi:10.1016/j.conb.2013.02.008
49. Shiffer D, Minonzio M, Dipaola F, et al. Effects of clockwise and counterclockwise job shift work rotation on sleep and work-life balance on hospital nurses. *Int J Environ Res Public Health*. 2018;15(9):2038. doi:10.3390/ijerph15092038