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Research Article

Influencing Factors for Sleep Quality Among Shift-working Nurses: A Cross-Sectional Study in China Using 3-factor Pittsburgh Sleep Quality Index

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SUMMARY

Purpose: The aim of this study was to identify influencing factors for sleep quality among shift-working nurses based on a three-factor scoring model that included sleep efficacy, sleep quality and daily dysfunction.

Methods: A cross-sectional survey of 513 nurses in a hospital in Shanghai, China, was conducted using a self-reported questionnaire. Sleep quality was measured by the Pittsburgh Sleep Quality Index (PSQI). Data were analyzed based on the three-factor PSQI model: Factor 1, sleep efficacy; Factor 2, sleep quality; Factor 3, daily disturbances.

Results: After adjusting for age, marital status, and having children, multivariate logistic regression analysis showed that participants who had previous shift work experience which was at least 6 months ago, or were currently performing shift work were significantly more likely to have poor sleep quality (PSQI > 5) than those who had never done shift work (adjusted odds ratios of 3.943 and 3.975, respectively, both $p < .001$). Mean scores of the three individual factors increased significantly among nurses currently performing shift work compared with those who had never done shift work (Factor 1, $\beta = 0.61$, $p < .001$; Factor 2, $\beta = 1.86$, $p < .001$; Factor 3, $\beta = 0.45$, $p = .002$). Mean scores of Factor 2 and Factor 3 increased significantly among nurses with previous shift work experience compared with those who had never done shift work (Factor 2, $\beta = 1.15$, $p = .003$; Factor 3, $\beta = 0.52$, $p = .005$).

Conclusions: Performing current shift work and performing shift work previously were significantly associated with poor sleep quality. An appropriate arrangement and intervention strategies are needed in Chinese hospitals in order to improve sleep quality among shift-working nurses.

Introduction

Sleep deprivation has been shown to negatively impact nurses' judgment and performance, and result in errors and accidents [1]. With a shortage in the supply of nurses and the increasing demand for nursing care, hospitals either require or allow nurses to work extended shifts (in excess of 12 hours) and many shifts per week (up to and in excess of 60 hours per week) [1]. The result of these excessive hours of work is that many nurses are caring for patients while they are experiencing sleep deprivation.

Poor subjective sleep quality and poor objective sleep stability occur frequently among hospital nursing staff [2]. The significant links between shift work status and sleep quality in nurses has been demonstrated in previous reports. The American Academy of Sleep Medicine defines the term “shift-work disorder” as the presence of excessive sleepiness or insomnia associated with working shifts [3]. Insomnia scores are shown to be positively associated with symptoms of shift-work disorder [4]. More than 70.0% of nurses reported having insufficient sleep, stress and rotating shift work-related symptoms [2,5]. A study of Japanese nurses demonstrated that nurses who spent more time working night shifts with little time for napping and an evening-oriented chronotype were more likely to have shift-work disorder and a lower health-related quality of life [6]. In a study in Norway [7], shift work and night work prevalence rates were 26.1% and 32.1%, respectively, and the prevalence of shift-work disorder in nurses

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was reported to be 32.4%–37.6%. Older age, male gender, evening-oriented chronotype, short intervals between shifts (i.e., less than 11 hours) and the number of nights worked over the last 12 months were shown to be risk factors for shift-work disorder [4]. However, other studies found no significant associations between sleep disturbances and shift work [2,8].

Nurses who work extended and unpredictable hours with a lack of regular breaks are likely to experience elevated fatigue and may fall asleep during their work shifts [8,9]. In a previous study, nurses reported struggling to remain awake during 36.0% of shifts. Moderate to high levels of stress, physical exhaustion, and mental exhaustion were reported on 23.0%, 40.0%, and 36.0% of shifts, respectively [10]. In that study, logistic regression analysis indicated that sleep duration was a significant predictor of the occurrence of errors during medical practice [10]. In particular, the risk of making an error almost doubled when nurses worked 12.5 or more consecutive hours [9]. Thus, both the health status of nurses and the quality of care provided by those nurses may be affected by poor sleep quality associated with hospital shift work [11]. Therefore, it is clinically important to demonstrate further the links between shift work status and sleep quality, and to identify the risk factors for poor sleep quality among nurses doing shift work.

The purpose of the present study was to identify risk factors for sleep disorders among shift-working staff nurses in a hospital in Shanghai, China, using the Pittsburgh Sleep Quality Index (PSQI) scale [12]. Since recent studies [13,14] have demonstrated that the PSQI is better characterized by a two-factor or three-factor scoring model than a one-factor model, we hypothesized that shift work status would have a distinct influence on all three factors—sleep efficiency, sleep quality and daily disturbances—in the expanded PSQI scale. Therefore, we used the three-factor scoring model in the present study to analyze the effects of nurses' shift work status (never, previously, and currently performing shift work) on sleep quality. Our study findings will be important for developing an appropriate program or strategy to overcome the sleep disorders among shift-working nurses.

Methods

Study design

A cross-sectional survey of 513 nurses in a single hospital was conducted using a self-reported questionnaire incorporating the previously validated Chinese version of the PSQI (C-PSQI) [12].

Setting and sample

A total of 1,026 registered nurses were identified by convenience sampling from one first class, tertiary-care hospital, the Shanghai Jiaotong University Affiliated Sixth People's Hospital in Shanghai, China, between August 1st, 2012 and August 30th, 2012. Inclusion criteria were registered nurses aged 19–55 with no history of major diseases, nonsmoking, nondrinking, not receiving pharmacotherapy, and willing to participate in a questionnaire survey. A total of 513 nurses who met the inclusion criteria were enrolled.

A sample size of 288 was required to ensure an acceptable margin of error within 5.0%. The formula applied was $n = 1.96^2 \times p \times (1-p)/0.05^2$, where $p = .75$ was the reported prevalence of poor sleep quality among nurses in China [2] and .05 indicated the acceptable margin of error (5.0%).

Ethical considerations

The study purpose was fully explained to all participants at the time of delivering the anonymous self-reported questionnaire. A returned questionnaire was considered indicative of consent to participate. The hospital institutional review board reviewed and approved the study protocol in 2013 (approval no. 2013-06).

Measurement

C-PSQI

The C-PSQI scale is a valid instrument used to measure the quality and patterns of sleep [12]. The PSQI is a 19-item self-reported questionnaire for evaluating sleep quality over the previous month. The 19 questions are combined into 7 clinically-derived component scores, including sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbance, use of sleep medication and daytime dysfunction. Each component is scored on a Likert-type 4-point scale (0, 1, 2, 3) and weighs equally from 0 to 3. The 7 component scores are added to obtain a global score ranging from 0 to 21, with higher scores indicating worse sleep quality [15]. A PSQI total score at 5 or more indicates poor sleep quality with a diagnostic sensitivity of 90.0% and a specificity of 67.0% [12]. Sleep quality was further analyzed based on the "three-factor model" PSQI proposed by Cole et al in 2006 [14]. Confirmatory analysis performed by those authors yielded three factors: Factor 1, sleep efficiency (sleep duration and sleep efficiency components); Factor 2, sleep quality (subjective sleep quality, sleep latency and sleep medication use components); and Factor 3, daily disturbances (sleep disturbances and daytime dysfunction components).

Data collection

Demographic information (age, marital status, with or without children), and shift work status of nurses were collected. Of the 513 nurses who received the survey, 487 finally returned completed questionnaires (94.9% response rate). All 487 were valid and included in the analysis. Cluster sampling was applied based on the shift work status of nurses: those who had never worked shifts, those who had shift work experience but had changed to daytime work (without work shift) for more than 6 months before they were recruited for this study, and those who were currently working shifts. In this hospital, a typical nurse worked two or three night shifts each week; each shift was 8 hours and each nurse cared for 30–35 patients during a night shift. Napping was not allowed.

Data analysis

The PSQI total score and the scores of the seven components in the PSQI scale, as well as the 3 factors in the three-factor model are presented as means and standard deviations. Age is presented as mean and standard deviation; other categorical data are presented as numbers and percentages. Univariate and multivariate logistic regression models were used to evaluate the influential factors for poor sleep quality (PSQI > 5). The score of seven components and three factors (Factor 1, sleep efficiency; Factor 2, sleep quality; Factor 3, daily disturbances) between the three groups of shift working nurses were compared using one-way analysis of variance, and the scores between any two groups or items were compared with Bonferroni post hoc tests. Univariate and multivariate linear regression were performed to investigate the correlations between shift work and the three factors. Multivariate linear regression was performed after adjusting for age, marital status, and having children. Statistical analyses were performed using IBM SPSS statistical software version 22.0 for Windows (IBM Corp., Armonk, New York, USA), and two-tailed $p < .05$ indicated statistical significance.

Results

The 487 nurses who returned the questionnaires were all female with a mean age of 28.8 years. The effect size was estimated to be .127 according to the total sample size of 487; α level was 5.0% and the power was 80.0% based on the outcomes of sleep quality at the time after the conclusion of the study. About half of nurses were married and 38.5% had children. Overall, 22.4% had never done shift work, 30.4% had done shift work previously and 47.2% were currently doing shift work or had very recently given it up. Over 70.0% of participants (72.1%) self-reported having poor sleep quality with PSQI > 5 (Table 1).

The univariate logistic regression model showed that age, marital status and having children were not related to the quality of sleep (PSQI > 5) in our participants. Only shift work status was shown to have a significant influence on poor sleep quality (Table 2). Those who had previously done shift work or were currently performing shift work were significantly more likely to have poor sleep quality than those who had never done shift work, with odds ratios (ORs) of 2.638 ($p < .001$) and 3.334 ($p < .001$), respectively (Table 2).

Multivariate logistic regression was performed subsequently. After adjusting for age, marital status, and having children, participants who had done shift work previously or were currently performing shift work were significantly more likely to have poor sleep quality than those who had never done shift work (adjusted OR = 3.943, $p < .001$ for those performing previous shift work, adjusted OR = 3.975, $p < .001$ for those performing current shift work) (Table 2).

We further evaluated the associations between sleep quality and shift work status by comparing the scores of the seven components and three factors of the PSQI between three groups of nurses (never, previously, and currently performed shift work) (Table 3). Shift work status was significantly associated with scores in the following domains: subjective sleep quality ($p < .001$), sleep latency ($p < .001$), sleep duration ($p = .001$), habitual sleep efficiency ($p = .026$), and daytime dysfunction ($p < .001$). The scores for sleep quality, sleep latency, sleep duration, habitual sleep efficiency and daytime dysfunction were significantly higher (poorer quality) in those who currently performed shift work than in those who had never performed shift work ($p < .05$). In addition, the scores for subjective sleep quality, sleep latency and daytime dysfunction of those nurses who had performed previous shift work, which was at least 6 months ago were also significantly higher (poorer quality) than in those who had never performed shift work ($p < .05$). No differences were found in scores for sleep disturbances or use of sleep medications between nurses in the three groups.

Based on the three-factor PSQI model, the scores for Factor 1 (sleep efficiency), Factor 2 (sleep quality) and Factor 3 (daily disturbances) were significantly higher (poorer quality) in those who currently performed shift work than in those who had never performed shift work (all $p \leq .05$) (Table 3). The scores for Factor 2 (sleep quality) and Factor 3 (daily disturbances) were also significantly higher (poorer quality) in those nurses who had performed shift work at least 6 months previously than in those who had never performed shift work (all $p < .05$). However, previous shift work experience did not affect sleep efficiency (Factor 1) (Table 3).

The correlations between shift work and the three PSQI factors were further analyzed by univariate and multivariate linear regression models (Table 4). The univariate linear regression model showed that shift work status had a significant influence on sleep efficiency, sleep quality, and daily disturbances. The mean sleep efficiency score increased significantly among nurses who were performing current shift work compared with those who had never done shift work ($\beta = 0.58$, $p < .001$). The mean sleep quality score increased significantly among nurses who had previous or current shift work compared with those who had never done shift work (previous: $\beta = 0.98$, $p = .002$; current: $\beta = 1.76$, $p < .001$). The mean daily disturbances score increased significantly among nurses who had previous or current shift work compared with those who had never done shift work (previous: $\beta = 0.66$, $p < .001$; current: $\beta = 0.51$, $p < .001$). The results revealed that those who had previously or were currently performing shift work were significantly more likely to have poor sleep efficiency, sleep quality, and daily disturbances.

Results of the multivariate models, after adjusting for age, marital status, and having children, were similar to the results of univariate models (Table 4). After adjustments, the mean sleep efficiency score increased significantly among nurses who had current shift work compared with those who had never done shift work ($\beta = 0.61$, $p < .001$); the mean sleep quality score and mean

Table 1 *Summary of Participant Characteristics (N = 487).*

Variables	*Mean* (*SD*)	*n* (%)
Age (yr)	28.8 (6.4)	
Marital status		
Yes		242 (49.7)
No		245 (50.3)
Children		
Yes		187 (38.5)
No		299 (61.5)
Shift work		
No		109 (22.4)
Previous shift work		148 (30.4)
Current shift work		230 (47.2)
Sleep quality		
Good (PSQI ≤ 5)		136 (27.9)
Poor (PSQI > 5)		351 (72.1)

Note. PSQI = Pittsburgh Sleep Quality Index.

Table 2 *Univariate and Multivariate Logistic Regression Analysis of Factors Associated with Poor Sleep Quality (PSQI score > 5).*

Influence factors	Variables	Univariate logistic regression		Multivariate logistic regression[a]	
		OR (95% CI)	*p*	Adjusted OR (95% CI)	*p*
Age (yr)		1.006 (0.976, 1.038)	.692	.998 (0.950, 1.048)	.930
Marital status	Yes	1.060 (0.713, 1.574)	.774	1.495 (0.702, 3.184)	.297
	No	Reference		Reference	
Children	Yes	1.121 (0.748, 1.681)	.579	1.194 (0.578, 2.465)	.632
	No	Reference		Reference	
Shift work	No	Reference		Reference	
	Previous shift work	2.638 (1.554, 4.478)	<.001*	3.943 (1.978, 7.862)	<.001*
	Current shift work	3.334 (2.037, 5.457)	<.001*	3.975 (2.339, 6.756)	<.001*

Note. CI = confidence interval; OR = odds ratio; PSQI = Pittsburgh Sleep Quality Index.
*$p < 0.05$ indicates that the corresponding factor had significant influence on sleep quality.
[a] Multivariate logistic regression was performed after adjusting for age, marital status, and children.

Table 3 *Associations Between Shift Work Status and Individual Factors of PSQI Three-factor Model.*

Factors & related components	Shift work status[a]			*p*
	No shift work ($n = 109$)	Previous shift work ($n = 148$)	Current shift work ($n = 230$)	
Factor 1: Sleep efficiency	1.43 ± 1.10	1.72 ± 1.27	2.01 ± 1.36[b]	<.001[c]
Sleep duration	1.18 ± 0.75	1.32 ± 0.77	1.52 ± 0.82[b]	.001[c]
Habitual sleep efficiency	0.25 ± 0.60	0.4 ± 0.73	0.49 ± 0.87[b]	.026[c]
Factor 2: Sleep quality	2.65 ± 2.10	3.63 ± 2.44[b]	4.41 ± 2.61[b,d]	<.001[c]
Subjective sleep quality	1.06 ± 0.61	1.35 ± 0.73[b]	1.45 ± 0.78[b]	<.001[c]
Sleep latency	1.55 ± 1.64	2.15 ± 1.77[b]	2.82 ± 1.85[b,d]	<.001[c]
Use of sleep medications	0.05 ± 0.25	0.13 ± 0.54	0.14 ± 0.50	.188
Factor 3: Daily disturbances	2.53 ± 1.27	3.19 ± 1.15[b]	3.04 ± 1.15[b]	< .001[c]
Sleep disturbances	0.96 ± 0.54	1.07 ± 0.57	1.03 ± 0.48	.284
Daytime dysfunction	1.57 ± 0.98	2.12 ± 0.84[b]	2.01 ± 0.88[b]	<.001[c]

[a] Data are presented as mean and standard deviation.
[b] $p < .05$ indicates a significant difference from the group that never performed shift work.
[c] $p < .05$ indicates a significant difference between the three subject groups of never, previously, and currently performing shift work.
[d] $p < .05$ indicates a significant difference from the group that had previously performed shift work.

daily disturbances score increased significantly among nurses who had previous or current shift work compared with those who had never done shift work (all $p \leq .005$).

Discussion

In this cross-sectional study, performed in a tertiary-care hospital in Shanghai, China, performing current shift work and having previous shift work were identified as the major factors that influenced sleep quality. In addition, based on the three-factor PSQI scoring model, current shift work was found to be significantly associated with all three factors—sleep efficiency, sleep quality and daily dysfunction. Previous shift work experience also affected sleep quality and caused daily dysfunction but did not affect sleep efficiency. These findings indicate clearly that appropriate arrangement of shift work for hospital nurses in China should be considered, not only to preserve the health status and sleep quality of nurses, but to reduce the risk of errors by sleep-deprived nurses and to help maintain the quality of healthcare overall.

Although some recent studies have shown that neither subjective nor objective sleep quality was related to shift work [1,7], and no clear indications demonstrated that irregular work hours caused chronic insomnia [16], results of the present study agreed with those from other studies which demonstrated significant associations between shift work and poor sleep quality [4,5,17,18]. Importantly, in the present study, even previous shift work experience was shown to affect sleep quality and sleep latency, causing daytime dysfunction. Our research focused mainly on the night shift when staff nurses are deprived of sleep. A typical nurse in our hospital works two to three night shifts each week. Each shift is 8 hours and each nurse cares for 30–35 patients during a night shift. This is a heavy burden and when nurses perform shift work day after day without a break, it may affect their sleep quality when they finally have time to sleep. In fact, one previous study found that sleep quality and mental health improved if nurses had two days off after their most recent night shifts [17]. In the present study, we did not use tools specifically to assess emotional disturbances or insomnia symptoms. However, we did find that shift work did not significantly increase scores for the use of sleep medications for insomnia.

The risk factors associated with poor sleep quality among hospital nurses may include shift work, chronic symptoms (e.g., headaches, gastric pain, neck and back pain, fatigue), personal lifestyle, working characteristics, and family structure [2,19]. More than 70.0% of the nurses in one study reported having insufficient sleep, stress and rotating shift work-related symptoms. Age, marital status and having children were unrelated to sleep quality in the present study, which agrees with study results reported by Chien et al [2]. However, another study by Chan [5] found that older age, perceived poor sleep status, gastrointestinal symptoms and higher levels of stress were risk factors that may contribute to insufficient sleep. Kageyama et al [20] also indicated that being 24 years old or younger and working three or fewer night shifts per month were two of the independent risk factors for insomnia. Although we did not evaluate insomnia specifically, multivariate logistic regression performed after adjusting for age, marital status, and children, showed that nurses currently performing shift work or who had done shift work previously were significantly more likely to have poor sleep quality (PSQI > 5) than those who had never done shift work.

The mechanism behind these disturbances involves the sleep-interfering properties of the circadian system during daytime sleep and the corresponding sleep-promoting properties during nighttime work [8,16]. The involvement of melatonin in the circadian system has been demonstrated [17], and the secretion of melatonin is known to be suppressed by light. Therefore, desynchronicity between the internal hormonal environment and the external environment may occur when melatonin levels are altered by workers' extended exposure to light while working night shifts, which may explain why nurses who work night shifts are susceptible to poor sleep quality [17]. In addition, a system of irregular rotating shifts, including night shifts, can cause changes in the secretion of hormones as shift work has a significant correlation with the serum levels of thyroid hormone and prolactin [21]. Thus, long nighttime working hours and the resulting interference with circadian rhythms are associated with the occurrence of shift-work disorder among nurses on rapid-rotation schedules [6]. No clear indications have suggested that irregular work hours cause chronic insomnia or a long-term effect on sleep quality [16].

The PSQI is a self-reported, subjective measure of sleep, and total PSQI scores are expected to relate closely to the individual scores for sleep quality, sleep latency and sleep duration. However, the three-factor scoring model (measuring sleep efficiency, sleep quality and daily disturbances) developed based on confirmatory factor analysis was shown to have a significantly better fit than either the original single-factor model or a two-factor model [13,14]. Benefits of the three-factor PSQI have also been validated in patients with posttraumatic stress disorder [22], and chronic fatigue syndrome [23]. In the present study, scores for Factor 1 (sleep efficiency), Factor 2 (sleep quality) and Factor 3 (daily disturbances) among nurses currently performing shift work were higher than those of nurses who had never performed shift work, showing that shift work is significantly associated with all three factors. Scores for sleep quality and daily disturbances were also increased in

Table 4 *Univariate and Multivariate Linear Regression Analysis of Associations Between Shift Work and Individual Factors of PSQI Three-factor Model.*

Influence factors	Variables	Univariate linear regression		Multivariate linear regression[a]	
		β ± *SE*	*p*	β ± *SE*	*p*
Factor 1: Sleep efficiency					
Shift work	No	Reference		Reference	
	Previous shift work	0.29 ± 0.16	.071	0.34 ± 0.20	.095
	Current shift work	0.58 ± 0.15	< .001*	0.61 ± 0.16	< .001*
Factor 2: Sleep quality					
Shift work	No	Reference		Reference	
	Previous shift work	0.98 ± 0.31	.002*	1.15 ± 0.38	.003*
	Current shift work	1.76 ± 0.29	< .001*	1.86 ± 0.30	< .001*
Factor 3: Daily disturbances					
Shift work	No	Reference		Reference	
	Previous shift work	0.66 ± 0.15	< .001*	0.52 ± 0.18	.005*
	Current shift work	0.51 ± 0.14	< .001*	0.45 ± 0.14	.002*

Note. PSQI = Pittsburgh Sleep Quality Index.
*$p < .05$ indicates that the corresponding factor had significant influence on sleep quality.
[a] Multivariate linear regression was performed after adjusting for age, marital status, and having children.

nurses who had previously performed shift work but without work shift for more than 6 months. Applying the three-factor model add confidence to the sleep quality analysis of the present study. Our findings also support the previous suggestion that the PSQI can assess the severity of sleep impairment in each of the three individual factors, which may help to identify the type and nature of sleep problems and provide guidance for selecting appropriate treatment [14].

Results showed that shift work was not significantly associated with the use of sleep medications. This may have been because current treatment guidelines recommend the use of nonpharmacologic interventions such as exercise and exposure to light for the treatment of shift work disorder [24]. Shift work disorder can be treated by behavioral, prescription, and nonprescription therapies. Nonpharmacologic therapies should be tried before considering sleep medications to promote sleep [25].

Results of the present study suggest that either current shift work or previous shift work, which was at least 6 months prior to the study is significantly associated with daily disturbances (Factor 3). In the three-factor PSQI model, daytime dysfunction and sleep disturbances contribute to daily disturbances. Shift-working nurses had poorer performance on visual attentive tasks than did off-duty nurses, which affected their mastery of high-attention tasks [26]. These results suggest a possible negative effect on the safety of both nurses and patients as a result of shift-related sleeplessness and daytime dysfunction. Another study also found that complaints of both insomnia and anxiety disorders were associated with poor daytime functioning in older adults [27]. On the PSQI, daytime dysfunction was evaluated with two questions: “During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?” and “During the past month, how much of a problem has it been for you to keep up enthusiasm to get things done?.” Among shift-working nurses, their clinical practice may have been affected more by excessive sleepiness than by reduced enthusiasm.

Limitations

The present study has limitations. It was conducted at a single tertiary-care hospital, thus limiting the generalization of results to other institutions, especially those with different levels of care. All participants were female with a median age of 28.8 years, so conclusions can only be made for this population. Also, the actual work shifts were not specified so actual differences between shifts such as evening versus night shifts (chronotype), 8-hour shift versus 12-hour shift (rotating schedules) were not determined. The long-term shift work history of each nurse (e.g., the average number of years that the nurses worked night shifts) and information about the total number of hours worked each week were not available. No tools were used specifically for the assessment of psychological factors (e.g., emotional disturbances). However, a recent report demonstrated that night-shift work and emotional disturbances were predictors of poor sleep quality and that chronotype was not a predictor of poor sleep quality [28]. No nonnursing population was included as a control group; however, the prevalence of poor sleep quality among shift workers in the general nonnurse population [29] was shown to be lower than that reported for nurses [17]. Additional multicenter studies are needed to confirm the results of the present study as well as to explore differences between various shift-work schedules and to consider other possible influencing factors such as emotional health and chronic fatigue.

Conclusion

The uniqueness of our study is using the three-factor PSQI to identify the influencing factors for sleep disorders among shift-working nurses. Our results strongly support the link between shift work status and sleep quality in shift-working nurses. Female staff nurses in China who were currently performing shift work had significantly poorer sleep quality than those who had never performed shift work. Shift work significantly influenced sleep efficiency and sleep quality, and significantly increased daily disturbances. Interestingly, previous shift work experience (nurses who had no work shift for more than 6 months) also affected sleep quality and caused daily disturbances, although it did not affect sleep efficiency. If shift work contributes to sleep disorders among nurses, even after they have changed their work schedule to daytime work, an appropriate arrangement of shift work for hospital nurses should be considered in order to reduce the risk of errors and to maintain the quality of healthcare. Results of the present study suggest that intervention strategies are needed in Chinese hospitals in order to create conditions that may improve sleep quality among shift-working nurses. Since shift work is a necessity in modern hospitals, our findings may be of value in developing strategies and education programs to reduce sleep-related problems among nurses.

Conflicts of interest

The authors have no conflicts of interest to report associated with this study.

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