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# Effect of Fast Shift Rotation and Slow Shift Rotation on the Nurses' Fatigue and Sleep Quality

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**Abstract:** Objective: The objective of this study was to investigate whether the three-shift fast rotation, two-shift fast rotation and night-shift slow rotation led to any differences in fatigue and sleep quality. Method: The study was conducted as a before–after study and 17 nurses participated in the study. Nurses on three-shift fast rotation were allocated to the pre-group, and two-shift fast rotation and night-shift slow rotation were allocated to the post-group. In the study period, all of the subjects experienced the three patterns of rotation. Occupational Fatigue Exhaustion/Recovery Scale (OFER15) and Athens Insomnia Scale were used to measure the participants' work-related fatigue and sleep quality three times. Results: Athens Insomnia Scale scores showed significant differences between the three types of shift rotation; two-shift fast rotation was  $3.88 \pm 2.35$ , three-shift fast rotation was  $8.63 \pm 3.50$ , and night-shift slow rotation was  $13.75 \pm 4.23$  ( $P < 0.05$ ). Therefore, the nurses' sleep quality through working on the two-shift rotation was better than the other two types of rotation. However, there were no significant differences in chronic fatigue, acute fatigue, and inter-shift [recovery] between the three types of rotations. Conclusion: Nurses who worked on the two-shift fast rotation had a better sleep quality than those who worked on the three-shift fast rotation and night-shift rotations. As sleep quality relates to the performance and alertness of nurses, greater attention should be paid to the use of different shift combinations to increase sleep quality and alertness. Considering sleep quality, a three-shift system arranged by two-shift fast rotation and combined with night-shift slow rotation is superior to the three-shift fast rotation.

**Keywords:** Shift Rotation, Fast Shift Rotation, Slow Shift Rotation, Nurses' Fatigue, Sleep Quality

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## 1. Introduction

Nearly 20% of the labor force worldwide work shifts which include work hours outside of 7 am to 18:00 pm [1]. Shift work, which disrupts the body's circadian rhythm and affects health, has been identified as an important source of occupational stress. The most common health-related effect of shift work is disturbed sleep, such as difficulty falling asleep and a shortened sleep duration [2]. Increasing evidence indicates that shift work schedules negatively influence worker physiology and health, for example they can result in circadian disruptions that are associated with cardiometabolic diseases, gastrointestinal health, and the worsening of mood disorders and depressive symptoms [3, 4]. Healthcare work is characterized by 24-hour operations, so that drawing upon

shift work is common for several nursing services. Shift work can be organized around fixed or rotating patterns. The fixed-shift pattern is where the employee works evenings or nights on a continuing basis and a rotated-shift pattern is where the employee may alternate between day, evening and night-shifts, or they may rotate between evening and nights [5]. Studies have shown that fixed shifts may increase the likelihood that workers will, with time, adapt to their shift schedules by adjusting their sleeping patterns, eating behavior, family life, and social life [5]. Other studies have reported that permanent fixed night workers generally report poorer health, more absenteeism, and less job satisfaction than fixed day workers [6]. Rotating shifts, if done on a weekly or monthly basis, may avoid some of the problems associated with fixed nights and reduce the likelihood of a worker ever becoming fully adjusted to a particular shift [5]. Studies have shown that

rotating shifts were significantly associated with acute fatigue, but when nurses work on schedules which are fixed on either days or nights, they can adapt to their schedule and may find successful strategies to reduce fatigue and increase recovery [7]. Furthermore, some studies have reported that nurses had a decrease in their perceptual and motor abilities on the three-shift system with fast rotation, suggesting that a fast rotating shift schedule may increase the risk of medical errors [8]. While many studies have investigated the influence of rotating shifts on night performance and sleep, little research has been performed on the influence of a three-shift fast rotation, two-shift fast rotation and night-shift slow rotation on sleep quality and work-related fatigue. In the authors' hospital, most nurses work on a three-shift system (8 hour shifts); two consecutive day shifts (8 am–15:30pm or 8 am–18:00 pm), two evening shifts (15:30 pm–22:30 pm), one night-shift (22:30–8 am), and then have at least 1 day off duty before restarting the cycle. Previous research showed that nurses who rotated with the fast three-shift system had a decrease in their perceptual and motor abilities on the night-shift. To reduce the disadvantage of a fast-rotating pattern, the hospital has to be encouraged to apply the alternative shift or combine other shift rotating patterns. This study investigated whether the three-shift fast rotation, two-shift fast rotation, and night-shift slow rotation led to any differences in fatigue and sleep quality.

## 2. Method

### 2.1. Participants and Procedures

This study was conducted in the surgical wards of The First Affiliated Hospital of Jinan University, Guangzhou, China. Participants were female nurses who provided direct care for patients, worked full-time schedules (7–10 hours per shift), and worked different shifts including day shifts (7 hours), evening shifts (7 hours), and night-shifts (10 hours). We excluded from the study nurses who had taken hypnotic drugs, sedatives, anti-inflammatory drugs, beta blockers, or antihistamines within four weeks of the study. In addition to those who had neurological diseases, metabolic diseases, renal diseases, and mental disorders. A total of 17 nurses met the selection criteria. The researcher explained the theme, purpose, study content, study time, methods, and protection of fundamental rights of the study to participants. After this explanation, 17 nurses agreed to participate. This study was conducted as a before–after study. Three-shift fast rotation were allocated to pre-group, and two-shift fast rotation and night-shift slow rotation were allocated to post-group. In the study period, all of the subjects experienced the three patterns of rotation.

For the three-shift fast rotation pattern, nurses were rotated on morning, evening, and night-shifts for one week, usually arranged on two day shifts, two evening shifts, one night-shift, and then had at least one day off duty before restarting the cycle. All the participants began from the day shift. For the two-shift fast rotation pattern, nurses were rotated on the

morning and evening shifts for one week, which were usually arranged as four day shifts, one day off, two evening shifts, and then at least one day off duty before restarting the cycle. All the participants began from the day shift. For the night-shift slow rotation pattern, nurses worked three–four nights, followed by four–three days off duty in one week.

### 2.2. Measurement

Sel-administered structured questionnaires were completed consisting of the following instruments: Basic sociodemographic data questionnaire, Athens Insomnia Scale, and Occupational Fatigue Exhaustion/Recovery Scale (OFER15).

#### 2.2.1. Athens Insomnia Scale (AIS)

The Chinese version of the Athens Insomnia Scale (AIS) was used in this study to measure the participants' sleep quality over the past month. AIS is considered to be an effective tool in sleep analysis, and it is validated in various countries following testing on local patients [9–11]. AIS is an eight-factor self-reported questionnaire, where the first five factors are related to nocturnal sleep and last three factors are related to daytime dysfunction. These are rated on a 0–3 scale and the sleep quality is finally evaluated from the cumulative score of all of the factors and reported as an individual's sleep outcome. Over the period of time, a cut-off score of  $\geq 6$  on the AIS was used to establish the diagnosis of insomnia [12, 8].

#### 2.2.2. Occupational Fatigue Exhaustion/Recovery Scale

The Chinese version of the Occupational Fatigue Exhaustion/Recovery Scale (OFER15) was used in this study to measure participants' work-related fatigue. OFER15 scale is composed of 15 items distributed on three subscales, each subscale consists of five items. Each item is rated with seven points on the Likert scale from "0" (strongly disagree) to "6" (strongly agree) [13]. This scale has been tested in different populations and has strong psychometric properties [14]. The Chinese version OFER's scale demonstrated high construct and face validity, and its three subscales showed good internal consistency reliability. Therefore, it is a reliable and valid instrument for assessing work-related fatigue in Chinese nurses [15].

### 2.3. Data and Statistical Analysis

The participants were surveyed 3 times: the first time was on the last day of the one month three-shift fast rotation period; the second time was on the last day of the one month two-shift fast rotation period; and the last time was on the last day of the one month night-shift slow rotation. AIS and OFER15 questionnaires were established online, and participants were invited to finish the questionnaire on the last day of each rotation pattern. Data collected were anonymous and completely confidential and were used only for academic research. All data were entered and analyzed using SPSS 13.0. Sleep quality and work-related fatigue were described using the descriptive statistics including mean and standard deviation. Pearson's correlation was used to examine the

relationships between the independent variables (shift rotation types) and the dependent variables (sleep quality and fatigue). The findings were significant at a value of  $P < 0.05$ .

### 3. Results

#### 3.1. Nurses' Sleep Quality Between the Three Types Shift Rotation

AIS scores showed significant differences between the

three types of shift rotation; two-shift fast rotation was  $3.88 \pm 2.35$ , three-shift fast rotation was  $8.63 \pm 3.50$ , and night-shift slow rotation was  $13.75 \pm 4.23$  ( $P < 0.05$ ). Therefore, the nurses' sleep quality when working on the two-shift rotation was better than the other two types of rotation. The eight-factor scores are shown in Table 1, and the total sleep duration, sleep quality, well-being during the day, functioning capacity during the day, and sleepiness during the day showed significant differences between the shifts.

**Table 1.** Eight-factor scores of AIS in three types of shift rotation.

	Three-shift fast rotation (Means)	Two-shift fast rotation (Means)	Night-shift slow rotation (Means)	F	P
Sleep induction	0.88	0.63	1.25	1.72	0.21
Awakenings during the night	0.88	0.75	1.30	1.27	0.68
Final awakening	0.5	0.5	1.25	3.31	0.06
Total sleep duration	1.88	0.50	1.25	12.01	0.00
Sleep quality	1.83	0.63	1.20	4.83	0.01
Well-being during the day	0.38	0.24	1.88	24.50	0.00
Functioning capacity during the day	1.38	0.13	2.38	18.56	0.00
Sleepiness during the day	1.13	0.75	2.63	17.64	0.00

#### 3.2. Work-Related Fatigue Between the Three Types Shift Rotation

Work-related fatigue scores showed no significant differences in chronic fatigue, acute fatigue, and inter-shift [recovery] between the three types of rotation.

**Table 2.** Work-related fatigue scores between the three types shift rotation ( $x \pm s$ ).

	Three-shift fast rotation	Two-shift fast rotation	Night-shift slow rotation	F	P
Chronic fatigue	$33.33 \pm 17.72$	$34.17 \pm 11.65$	$36.66 \pm 18.60$	0.09	0.91
Acute fatigue	$48.33 \pm 12.84$	$41.25 \pm 17.82$	$46.25 \pm 14.08$	0.46	0.63
Inter-shift [recovery]	$46.66 \pm 4.71$	$43.75 \pm 12.00$	$45.41 \pm 9.58$	0.19	0.82

### 4. Discussion

Shift work has significantly changed nurses' sleep patterns, between 57% and 83.2% [16, 17]. Poor sleep quality and insufficient sleep have an injurious effect on both the health and performance of nurses [18]. The results of this study suggest that there were significant differences in sleep quality between three different types of shift rotation, as measured by AIS. Nurses with the best sleep quality worked a two-shift rotation and on the other two types of shift rotation (three-shift fast rotation and night-shift rotation), nurses were diagnosed with insomnia (AIS scores  $> 6$ ). Prior research has reported that insufficient sleep and poor sleep quality impact metabolism, the immune system, and the digestive system resulting in psychophysiological health problems such as emotional disturbances [19, 20]. Other studies have shown that the better the sleep at night, the greater the daytime alertness [21], meaning that in this study daytime alertness was higher when nurses were on the two-shift fast rotation pattern as opposed to the other two. Five of the eight factors of the OFER15 scale showed significant differences. Rotating shifts change frequently from day to night-shifts and most nurses working night-shifts struggle to adjust to daytime activities or normal night sleep patterns on their days off [18]. In this study, nurses had the best total sleep time and daytime

performance on the two-shift fast rotation pattern, followed by the three-shift fast rotation and then the night-shift slow rotation pattern. As the two-shift fast rotation pattern rotated between morning and evening shifts and did not include night-shifts, it had less interference on the circadian rhythm. Nurses reported less well-being and more sleepiness during the day when on the night-shift slow rotation pattern. However, these two factors were asked with regard to the daytime situation, but as the daytime was the rest time for the nurses on this type of rotation led to this result.

Work-related fatigue is one of the most common phenomena among shift workers, particularly nurses [22]. Studies found that 91.9% of nurses complained of work-related fatigue with a higher level among female nurses [23]. Concerning fatigue, the study revealed that in an eight hour shift system there were no significant differences in fatigue (chronic fatigue, acute fatigue, and inter-shift [recovery]) between the three types of rotations as measured by the Occupational Fatigue Exhaustion/Recovery Scale, but the study had a lower average score than other studies [22]. The result is supported by previous studies which showed no significant relationship between the number of night-shifts and fatigue [24, 25]. Furthermore, other previous studies have reported that the number of night and evening shifts per month had indirect effects on both acute and chronic fatigue, as well

as on inter-shift recovery [26]. The study findings also indicated that the scores of chronic and acute fatigue, which are inconsistent with a previous study [27], were lower than the mentioned studies and might be interpreted differently due to the working hours; in this study nurses worked 7–10 hours per shift. Furthermore, some studies have documented nurses working daily shifts of 8–9 or 9–10 hours reported lower physical fatigue than nurses working daily shifts of 10–11 or more than 12 hours [28].

## 5. Conclusion

The findings of this study indicate that in the three-shift system, the nurses who worked on the two-shift fast rotation had a better sleep quality than those who worked on the three-shift fast rotation and night-shift rotation. As sleep quality is related to the performance and alertness of nurses, greater attention should be paid to different shift combinations with a view to increasing the sleep quality and alertness. Different combinations of the three-shift system had different effects on the sleep quality of nurses. Nurses on the three-shift fast rotation (rotated morning, evening, and nights in one week) had affected sleep quality and were diagnosed with insomnia. However, when the two-shift fast rotation was combined with the night-shift slow rotation pattern, sleep quality was effected only when the nurses were in the night-shift slow rotation period (one month), and there were no effects on the sleep quality of the nurses on the two-shift fast rotation period. Considering sleep quality, a three-shift system arranged by two-shift fast rotation and combined with a night-shift slow rotation, is superior to the three-shift fast rotation.

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## Conflict of Interest

All authors declare that they have no conflicts of interest.

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