

Comparison of Sleep Quality and Fatigue among Shift Work Nurses across Different Age Groups in Japan

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Abstract

Purpose: To clarify the differences in sleep quality and fatigue among shift-working nurses based on age. **Design:** A descriptive correlation design using self-administered surveys. **Methods:** Questionnaires on fatigue, sleep satisfaction, and sleep quality (the Pittsburgh Sleep Quality Index; PSQI-J) among shift work nurses were distributed to 1190 nurses in Japan from July 2023 to August 2023. **Results:** Sleep satisfaction daily ($p < 0.001$) and pre-night shift sleep duration ($p < 0.001$) were significantly higher in the younger group, who also experienced a longer time to fall asleep ($p = 0.014$) and longer daytime naps before ($p = 0.024$) and after the night shift ($p = 0.007$). In addition, the older group experienced higher fatigue levels both daily ($p = 0.038$) and night shifts ($p = 0.006$). More morning-type nurses were observed in the older than in the younger age group ($p = 0.001$). No significant differences were noted in PSQI between the two groups. **Conclusions:** The older age group experienced higher levels of both regular fatigue and night shift fatigue compared to the younger group, suggesting they may not be getting sufficient rest after work. Although their sleep duration was shorter than that of the younger group, sleep quality was low in both groups, with 60% reporting poor sleep quality.

Keywords

Shift Work, Nurse, Age, Fatigue, Sleep Quality

1. Introduction

Shift workers have been shown to be at a higher risk of developing various diseases, including obesity, hypertension, diabetes, ischemic heart disease, cancer, and depression [1]-[7]. In 2007, the International Agency for Research on Cancer (IARC) classified “shift work” as a “probable human carcinogen” (Group 2A), suggesting a potential association with carcinogenicity [8]. Nurses who have en-

gaged in shift work for more than 20 years have a 1.79 times higher risk of developing breast cancer compared to nurses with non-shift work schedules [9]. Melatonin is secreted in a dark environment at night, promoting sleep onset and regulating the sleep-wake cycle. Additionally, melatonin is involved in the autonomic nervous system and immune system, contributing to improvements in quality of life, the prevention of osteoporosis, cancer suppression, and anti-aging effects [10]. However, exposure to light at night and reduced daytime light exposure can suppress melatonin secretion [11] [12]. Nurses who work night shifts are exposed to light at night, and experience reduced light exposure during the day due to daytime naps. Therefore, it may lead to suppressed melatonin secretion, disruption of biological rhythms, and an increased risk of various diseases in nurses.

In Japan, nurses primarily work under a two-shift system, with day shifts lasting 8 hours (8:00 - 16:00) and night shifts typically extending to 16 hours (16:00 - 8:00). Although night shifts include rest breaks and naps, the extended 16-hour shift places a significant physical and mental burden on nurses, leading to high levels of fatigue. More errors occur when nurses work longer than 12 hours [13]. When high stress is combined with irregular hours in nursing, results include fatigue and lower performance [14]. For nurses working in a shift system, improving sleep quality and facilitating fatigue recovery are essential for managing the disruption of biological rhythms caused by long night shifts and sustaining their ability to continue working.

Human sleep patterns change with age, with total sleep duration decreasing, nighttime awakenings increasing, and sleep efficiency declining. As a result, aging is associated with a decrease in sleep quality [15]. Sleep quality is likely to vary depending on age, which may also affect the degree of fatigue and recovery among shift-working nurses. Sleep patterns and sleep quality change with aging. In the early 20s, individuals tend to go to bed late at night and wake up late in the morning. However, after the age of 25, they gradually shift toward an earlier bedtime and wake-up time [16] [17]. Additionally, the actual amount of sleep obtained at night gradually decreases with age. It is said that around the age of 15, individuals sleep for approximately 8 hours, while at 25, this decreases to about 7 hours. By the age of 45, nighttime sleep duration is around 6.5 hours, and by 65, it further declines to approximately 6 hours [18]. Nurses work long night shifts and are responsible for patients' lives, leading to high physical and mental fatigue, making regular sleep extremely important. In shift work, sleep schedules become irregular, disrupting the body's biological rhythm. Additionally, since sleep characteristics vary with age, sleep quality among nurses may differ depending on age, potentially affecting fatigue recovery.

Therefore, this study aims to clarify the differences in sleep quality and fatigue among shift-working nurses based on age.

2. Methods

2.1. Study Design

A cross-sectional design using self-administered surveys was used to study shift

work nurses in Japan.

2.2. Participants and Setting

The study targeted shift-working nurses with at least two years of experience employed at 120 randomly selected hospitals with over 200 beds in the Kansai region of Japan using a random number table. At each facility, up to 50 nurses were included, or fewer if desired, while ensuring no extreme bias in years of experience. Among the 6000 nurses from 120 facilities, it was assumed that 60% would receive cooperation from nursing managers for the study, and 30% would respond via a mail survey. Based on these assumptions, the sample size was determined. A total of 1190 nurses from 27 hospitals were included in the study. Nurses who were not regularly engaged in shift work, those working exclusively night shifts or day shifts, and part-time workers were excluded.

2.3. Procedure

This study was approved by the Institutional Review Board, Graduate School of Nursing, Osaka Metropolitan University (approval number: 2022-36). Following the declaration of Helsinki, the study was conducted. From July 2023 to August 2023, a research request letter was sent to the nursing administrators of the selected facilities. For facilities that agreed to participate, request letters and questionnaires were distributed by mail to the target nurses. Participation in the survey was voluntary. During the one-month study period, participants were requested to place the completed questionnaire in an envelope and return it. Consent for study participation was obtained by having participants indicate their agreement within the survey form.

2.4. Independent Variables

The survey covered participants' characteristics about age, gender, years of experience, ward characteristics, marital status, and presence of children. It also included the Morningness-Eveningness Questionnaire, sleep quality assessments using the Pittsburgh Sleep Quality Index (PSQI), and sleep satisfaction measured with a visual analog scale (VAS). Additionally, the survey examined physical and mental health, including subjective health status (VAS) and fatigue levels during daily life and work (VAS). The estimated time required to complete the questionnaire was approximately 25 minutes. The Pittsburgh Sleep Quality Index (PSQI) was developed by the University of Pittsburgh to assess sleep habits and sleep quality over the past month. In this study, we used the Japanese version developed by Doi *et al.* [19]. The questionnaire consists of 18 items, which can be categorized into seven components: "sleep quality," "sleep duration," "sleep onset latency," "sleep efficiency," "sleep disturbances," "use of sleep medication," and "daytime dysfunction." A higher total score indicates greater sleep impairment, with a cut-off score of 5.5 points [20]. Reliability for the PSQI-J is established with a reported range of 0.64 - 0.87 [21]. The Morning-Evening Questionnaire (MEQ) is a 19-item

questionnaire used to determine whether an individual has a morning or evening chronotype based on their sleep and eating habits. It was originally developed in English by Horne *et al.* (1976) and later adapted into Japanese by Ishihara *et al.* (1986) [22] [23]. Both the PSQI and MEQ scales can be used without permission from the developers. In addition, I investigated smartphone viewing habits that may affect sleep quality. The visual analog scale (VAS) is a widely used tool that quantifies subjective experiences by measuring the distance from the left end of a 10 cm straight line to the marked point, representing the perceived intensity of a given variable [24].

2.5. Statistical Analysis

The findings were analyzed using IBM Statistics SPSS 25.0. Descriptive statistics were used to summarize the sleep and fatigue levels of shift-working nurses, presented as means and standard deviations. Participants were divided into two groups: those above the median age (the older group) and those below the median age (the younger group). The Levene test was used to examine the homogeneity of variance. Independent t-tests, chi-square tests, and Fisher's exact test were conducted to compare the two groups. A significance level of $p < 0.05$ was considered statistically significant.

3. Results

Out of 1190 participants, 614 participants replied to the questionnaire, demonstrating a 51.6% response rate.

3.1. Characteristics of Participants

The average age was (35.8 ± 10.5) years, with 12.3% males ($n = 75$) and 87.7% ($n = 534$) females. Nurses were categorized into older (the average age: (45.7 ± 6.4) years) and younger groups (the average age: (26.8 ± 3.2) years) based on the median age (34.0 years). 88.1% were female, 58.7% were married, 74.9% lived with their family, and 59.5% had children in the older group. On the other side, 87.1% were female, 17.8% were married, 41.9% lived alone, and 91.1% did not have children in the younger group. The nurses worked on various wards, including post-surgical (9.2%), internal/medical 26.1%), a combination of post-surgical and internal/medical (14.5%), (6.9%), and other (10.3%) in the older group. The nurses worked on various wards, including post-surgical (9.2%), internal/medical 26.1%), a combination of post-surgical and internal/medical (14.5%), Intensive Care Unit/High Care Unit/Cardiac Care Unit (6.9%), emergency ward (1.7%) and other (41.3%). In the younger group, nurses worked on post-surgical (19.5%), internal/medical (23.8%), combination of post-surgical and internal/medical (21.1%), Intensive Care Unit/High Care Unit/Cardiac Care Unit (7.9%), emergency ward (2.3%) and other (24.4%). In the older age group, 77.8% graduated from a nursing vocational school, while 10.5% had a university degree. In contrast, in the younger age group, 51.3% graduated from a vocational school, and 41.1% had a university

degree. **Table 1** lists other sample characteristics.

Table 1. Characteristics among participants.

		Older Age Group N = 302	Younger Age Group N = 303	χ^2	P value
Sex	Male	36 (11.9)	39 (12.9)	0.126	0.723
	Female	266 (88.1)	264 (87.1)		
Ward	Surgical department	28 (9.2)	59 (19.5)	29.678	<0.001
	Internal/medical department	79 (26.1)	72 (23.8)		
	Medical and surgical mixed department	44 (14.5)	64 (21.1)		
	ICU, HCU, CCU	21 (6.9)	24 (7.9)		
	Emergency department	5 (1.7)	7 (2.3)		
	Others	125 (41.3)	74 (24.4)		
	Surgery mixed department	1 (0.3)	3 (1.0)		
Nursing Experience (Year)	1 - 4	11 (3.8)	165 (57.9)	384.920	<0.001
	5 - 9	21 (7.3)	97 (34.0)		
	10 - 19	116 (40.4)	23 (8.1)		
	20 - 29	106 (36.9)	0 (0.0)		
	30-	33 (11.5)	0 (0.0)		
Highest Level of Education	Vocational School (registered nurse)	238 (77.8)	156 (51.3)	81.266	<0.001
	Junior College	22 (7.2)	8 (2.6)		
	Four-Year University	32 (10.5)	125 (41.1)		
	Master's Degree Program	4 (1.3)	1 (0.3)		
	High School Health and Nursing Department	5 (1.6)	8 (2.6)		
	Others	5 (1.6)	6 (2.0)		
Midwifery Qualifications	Have	11 (3.6)	18 (5.9)	1.823	0.177
	Not have	295 (96.4)	286 (94.1)		
Public Health Nurse Qualification	Have	19 (6.2)	44 (14.5)	11.247	0.001
	Not have	287 (93.8)	260 (85.5)		
Marriage	Be married	179 (58.7)	54 (17.8)	107.95	<0.001
	Be not married	126 (41.3)	250 (82.2)		
Children	Have children	182 (59.5)	27 (8.9)	173.32	<0.001
	Do not have children	124 (40.5)	277 (91.1)		
Live together Someone	Living alone	72 (23.8)	127 (41.9)	36.476	<0.001
	Living with family	227 (74.9)	158 (52.1)		
	Others	4 (1.3)	18 (5.9)		

Qui-square test (n (%)).

3.2. Comparison of Sleep Quality and Fatigue Level with the Older Group and the Younger Group

Table 2 shows a comparison of sleep quality and fatigue levels between the older group and the younger group.

Sleep satisfaction daily ($p < 0.001$) and pre-night shift sleep duration ($p < 0.001$) were significantly higher in the younger group, who also experienced a longer time to fall asleep ($p = 0.014$) and longer daytime naps before ($p = 0.024$) and after the night shift ($p = 0.007$). In addition, the older group experienced higher fatigue levels both daily ($p = 0.038$) and night shifts ($p = 0.006$).

Table 2. Comparison of sleep patterns and fatigue among nurses on age.

	Older Age Group N = 302	Younger Age Group N = 303	T/ χ^2	P value	
Usual times on sleep in the past month (hour)†	6.2 ± 1.1	6.5 ± 1.2	3.319	0.001	
Times it takes to get to sleep (minute)†	26.4 ± 22.1	31.2 ± 24.2	2.454	0.014	
Falling asleep during sleep††	Good	145 (47.5)	114 (37.7)	9.539	0.008
	Bad	65 (21.3)	58 (19.2)		
	Usually	95 (31.1)	130 (43.0)		
Usual nighttime sleep satisfaction (VAS)†	44.6 ± 22.9	52.9 ± 22.8	4.430	<0.001	
Current levels of health (VAS)†	55.9 ± 20.9	57.5 ± 20.0	0.974	0.331	
Current levels of stress (VAS)†	67.0 ± 20.6	61.3 ± 20.4	-3.390	0.001	
Current levels of fatigue (VAS)†	68.3 ± 20.6	64.8 ± 20.0	-2.075	0.038	
Levels of fatigue on a night shift work (VAS)†	80.6 ± 16.0	77.0 ± 15.7	-2.740	0.006	
Times on sleep before a night shift work (minute)†	491.0 ± 112.7	585.8 ± 124.2	9.471	<0.001	
Nap time before a night shift work (minute)†	128.6 ± 78.8	147.5 ± 98.6	2.268	0.024	
Nap time after a night shift work (minute)†	230.6 ± 89.1	255.2 ± 92.1	2.720	0.007	

†: Independent-samples T test (mean ± SD); ††: Qui-square test (n (%)); VAS: visual analog scale (mm).

3.3. Smartphone Use at Night and Daily among Participants

Table 3 shows smartphone use at nighttime and daily among nurses. The daily smartphone screen time was significantly longer in the younger age group than in the older group. Additionally, more than 90% of individuals in both age groups used their smartphones within two hours before bedtime. In the younger group, 97% used their smartphones, which was higher than 92.5% in the older age group. Regarding when they stopped using their smartphones, around 80% of individuals in both groups reported using them until 30 minutes before bedtime or right before sleeping, with 78% in the older group and 81% in the younger group.

Table 3. Smartphone use among nurses on a daily basis and before going to bed.

		Older Age Group N = 302	Younger Age Group N = 303	χ^2	P value
Using a smartphone within 2 hours of going to bed††	Use	282 (92.5)	294 (97.0)	6.368	0.012
	Not used	23 (7.5)	9 (3.0)		
Daily smartphone viewing time (hour)†		2.6 ± 2.1	4.5 ± 2.4	9.376	<0.001
When to stop using your smartphone before going to bed††	Until 2 hours before bedtime	10 (3.3)	2 (0.7)	5.668	0.129
	2 to 1 hour before bedtime	11 (3.6)	11 (3.7)		
	1 hour to 30 minutes before bedtime	46 (15.1)	42 (14.0)		
	30 minutes to just before bedtime	237 (78.0)	246 (81.7)		

†: Independent-samples T test (mean ± SD); ††: Qui-square test (n (%)).

3.4. PSQI Scores and MEQ Score

Table 4 shows the results of the MEQ and PSQI among nurses. In the older age group, approximately 35% were classified as morning types, which was higher than in the younger group. On the other hand, about 12% of the younger group were classified as evening types, compared to 4% in the older group ($p = 0.001$). The PSQI score averaged (6.7 ± 2.9) points in the older group and (6.5 ± 2.8) points in the younger group, with both groups scoring above the Japanese version of the PSQI cutoff score of 5.5 points. Additionally, 60.2% of the older group and 62.8% of the younger age group were classified as having a sleep disorder. In addition, the effect of MEQ on PSQI in both the older and younger age groups is presented in **Table 5**. No significant differences were observed in the younger age group; however, in the older age group, a higher proportion of morning-type individuals exhibited better sleep quality ($p = 0.032$).

Table 4. PSQI score and MEQ among nurses on age.

		Older Age Group	Younger Age Group	χ^2/T	P value
MEQ judgment††	Clearly morning type	5 (2.3)	2 (0.9)	19.73	0.001
	Mostly morning type	71 (33.3)	39 (18.3)		
	Intermediate type	128 (60.1)	147 (69.0)		
	Mostly evening type	9 (4.2)	24 (11.3)		
	Clearly evening type	0 (0.0)	1 (0.5)		
PSQI score†		6.7 ± 2.9	6.5 ± 2.8	-0.376	0.707
Sleep disorders††	Have	62 (60.2)	54 (62.8)	0.133	0.715
	Not have	41 (39.8)	32 (37.2)		

†: Independent-samples T test (mean ± SD); ††: Qui-square test (n (%)); MEQ: Morningness-Eveningness Questionnaire; PSQI: Pittsburgh Sleep Quality Index.

Table 5. PSQI score and MEQ among nurses on age.

		Good Sleep Quality PSQI Score < 5.5	Bad Sleep Quality PSQI Score > 5.5	χ^2	P value
Older Age Group					
MEQ Judgment	Morning type	15 (45.5)	7 (17.9)	6.906	0.032
	Intermediate type	18 (54.5)	31 (79.5)		
	Evening type	0 (0.0)	1 (2.6)		
Younger Age Group					
MEQ Judgment	Morning type	6 (24.0)	4 (11.4)	1.957	0.376
	Intermediate type	17 (68.0)	26 (74.3)		
	Evening type	2 (4.2)	5 (14.3)		

Qui-square test (n (%)); MEQ: Morningness-Eveningness Questionnaire; PSQI: Pittsburgh Sleep Quality Index.

4. Discussion

This study focused on nurses engaged in shift work, including night shifts, and compared sleep quality and fatigue between older and younger age groups.

The sleep satisfaction score of the VAS was higher in the younger age group than in the older age group. However, even in the younger group, the average satisfaction level was around 50%, indicating that overall nighttime sleep satisfaction was low. Before a night shift, the younger age group slept an average of more than 9 hours, whereas the older age group slept approximately 8 hours on average. In the older age group, a higher proportion of individuals were married or had children, requiring time for household chores and childcare, which may contribute to shorter sleep duration compared to younger individuals. Additionally, fatigue levels during night shifts were higher than usual, with the older age group experiencing greater fatigue. The current levels of fatigue and stress remained at around 60% in both groups, with the older age group experiencing higher levels. Low sleep satisfaction and shorter sleep duration before night shifts suggest that sleep quality may not be sufficient for adequate fatigue recovery. Additionally, this may have an impact on stress levels. Regarding usual sleep onset time, the younger age group took longer to fall asleep. Additionally, in the PSQI assessment, 60% of individuals in both groups were classified as having a sleep disorder. The fact that more than half of the nurses have sleep disorders suggests that they may be working without fully recovering from fatigue. This poses a risk of medical errors and other incidents, which is particularly concerning given their responsibility for patients' lives. In menopausal women, insomnia symptoms related to estrogen deficiency have been noted. This study did not directly assess the impact of menopausal symptoms; however, this is an important factor that should be considered in future research. While the influence of menopause-specific symptoms cannot be ruled out in this study, the high prevalence of sleep disorders, even in the younger age group, suggests that other factors may also be contributing.

Shift work, including night shifts, disrupts the body's biological rhythm, expos-

ing workers to light during hours when they should be sleeping at night. Health issues associated with shift work have long been recognized, including obesity, heart disease, depression, hypertension, cancer, and stroke [1]-[9]. Melatonin, a hormone associated with the body's biological rhythm, is secreted at night and plays a role in regulating circadian rhythms and promoting sleep, thereby influencing sleep quality. Exposure to light at night suppresses melatonin secretion, while exposure to light during the day is said to increase its production. Nurses working night shifts are exposed to light at night and may experience reduced light exposure during the day due to daytime naps, which can suppress melatonin secretion. This may lead to disruptions in circadian rhythm regulation and a decline in sleep quality. Shift-working nurses, influenced by hormonal imbalances, are forced to continue their demanding duties while facing significant physical and mental health risks.

Making efforts to improve sleep quality in daily life contributes to maintaining nurses' physical and mental health. This, in turn, helps sustain the quality of medical care and enhances safety by preventing medical errors.

Blue light from smartphone screens is said to affect sleep quality. Smartphones have become an essential part of daily life, serving not only as a communication tool but also as a platform for information sharing, accessing the latest news, and entertainment. With various applications for gaming, watching videos and images, and listening to music, smartphones can be considered a multifunctional tool that fulfills various personal needs. However, prolonged smartphone use and screen time before bedtime can negatively affect sleep, not only due to blue light exposure but also by stimulating brain activity, making it harder to fall asleep [25]. In this study, an analysis of smartphone screen time revealed that the older age group had an average daily usage of 2.6 hours, while the younger age group averaged 4 hours.

For nurses working day shifts, spending several hours on their smartphones before bedtime, despite responsibilities such as household chores and childcare after returning home, takes up a significant portion of their non-working hours. Reducing exposure to blue light from smartphones before bedtime may facilitate faster sleep onset and enhance overall sleep quality. The study found that over 90% of nurses in both age groups used their smartphones within two hours before bedtime, and about 80% in both groups stopped using them just before sleep. Regarding sleep onset, the younger age group took longer to fall asleep than the older group, with an average of 31 minutes. Karas *et al.* also demonstrated a link between smartphone addiction, depressive symptoms, anxiety, and poor sleep quality in older adults [26]. After returning home from work, reducing smartphone screen time may help the brain relax, leading to better sleep onset and improved sleep quality. Given the irregular lifestyle associated with night shifts, adjusting environmental factors—such as using night mode on smartphone and computer screens and dimming room lighting—could be beneficial in promoting better sleep.

The older age group experienced higher fatigue levels and insufficient recovery compared to the younger group. As individuals age, changes in sleep patterns are observed, including a reduction in total sleep duration, an increase in nighttime awakenings, and a decline in sleep efficiency. Consequently, aging is linked to a deterioration in sleep quality [15]. Lin *et al.* demonstrated that heightened fatigue is linked to poor sleep quality and a decline in health status among shift work nurses [27]. In addition, nighttime sleep duration gradually decreases with age, dropping to approximately 6.5 hours by the age of 45 and further declining to around 6 hours by the age of 65 [18]. Caruso showed that long hours among shift workers might be associated with lower performance, injuries, chronic diseases, and fatigue-related errors [28]. On the other hand, it is essential to review their environment and lifestyle to improve sleep quality and enhance fatigue recovery. The older age group has limited time to rest after work due to household chores and childcare responsibilities, compared to younger individuals. However, it is important to establish habits that promote both physical and mental relaxation in alignment with nighttime sleep. A good starting point may be reassessing smartphone usage before bedtime. Furthermore, improving the sleep environment before and after night shifts is essential to maintaining nurses' health. Specifically, reducing blue light exposure, reviewing shifts, and managing rest to promote fatigue recovery are important measures.

5. Limitations

This study obtained subjective data through a self-administered questionnaire; however, it did not include objective verification. Therefore, future research should incorporate objective data alongside subjective indicators for a more comprehensive evaluation. As this study relied on self-reported data, future research should incorporate objective measures, such as actigraphy, to more accurately assess sleep quality. Additionally, the high number of missing values in the PSQI may have introduced bias in the results, highlighting the need for continued verification. Furthermore, to examine the impact of age on sleep and fatigue, potential confounding variables such as work schedules, workload, family responsibilities, and health status should be adjusted for and further investigated.

6. Conclusion

The older age group experienced higher levels of both regular fatigue and night shift fatigue compared to the younger group, suggesting they may not be getting sufficient rest after work. Although their sleep duration was shorter than that of the younger group, sleep quality was low in both groups, with 60% reporting poor sleep quality. Many individuals continued using their smartphones until just before bedtime, suggesting a potential impact on sleep onset and sleep quality. The older age group, in addition to their work responsibilities, also had household and childcare duties. Therefore, it is crucial for them to create a sleep-friendly environment and adopt relaxation habits suited to their individual needs to support fatigue recovery.

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Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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