

Relationship Between Shift Intensity and Insomnia Among Hospital Nurses in Korea: A Cross-sectional Study

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Objectives: This study explored the relationship between shift intensity and insomnia among hospital nurses.

Methods: The participants were 386 female hospital nurses who underwent a special health examination for night workers in 2015. The Korean Insomnia Severity Index (ISI), indices of shift work intensity, and other covariates such as amount of exercise, level of alcohol consumption, employment duration, and hours worked were extracted from the health examination data. The indices for shift intensity were (1) number of 3 consecutive night shifts and (2) number of short recovery periods after a previous shift, both assessed over the prior 3 months. Multiple logistic regression analysis adjusted for the aforementioned covariates was performed to evaluate the association of shift intensity with insomnia, defined as an ISI score of ≥ 8 .

Results: The nurses with insomnia tended to be younger ($p=0.029$), to have worked 3 consecutive night shifts more frequently ($p<0.001$), to have experienced a greater number of short recovery periods after the previous shift ($p=0.021$), and to have worked for more hours ($p=0.006$) than the nurses without insomnia. Among the other variables, no statistically significant differences between groups were observed. Experiences of 3 or more consecutive night shifts (odds ratio [OR], 2.33; 95% confidence interval [CI], 1.29 to 4.20) and 3 or more short recovery periods (OR, 2.01; 95% CI, 1.08 to 3.73) were associated with increased odds of insomnia.

Conclusions: The results suggest that decreasing the shift intensity may reduce insomnia among hospital nurses working rotating shifts.

Key words: Nurses, Shift work, Night work, Insomnia, Shift intensity

INTRODUCTION

Nursing is a well-known example of an occupation that requires shift work, which is known to be associated with physi-

cal health problems such as metabolic syndrome [1] and heart disease [2], as well as mental health problems such as depression, anxiety, and insomnia [3-5]. In particular, insomnia among nurses has been reported to lead to work-related mistakes, potentially threatening patient safety [6,7].

Associations between shift work and insomnia [8,9], decreased sleep quality [10], daytime sleepiness [3], and fatigue [11] among rotating shift nurses have been consistently reported. To combat such problems, previous studies have suggested individual-level strategies in which a nurse's lifestyle habits and personality characteristics are analyzed to devise a solution [12,13]. However, as individual-level interventions have shown limited

Received: November 12, 2020 Accepted: November 26, 2020

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effectiveness, more effective organization-level interventions, such as improvements in shift work schedules, provision of nap breaks, increased social support, and improvements in the work environment, may be necessary [14,15].

The strategic rearrangement of shift schedules is a potential interventional measure, but its effectiveness has not been adequately confirmed by empirical epidemiological studies. Most studies dealing with the health effects of rotating shifts among nurses have compared shift workers and daytime regular workers; only a few quantitative studies have compared 2-shift and 3-shift work [16,17]. According to a recent review article, engagement in shift work has been the sole independent variable in most Korean studies on this topic; the relationships between more specific characteristics of shift work (e.g., shift work type, duration, and frequency) and health problems have been explored in only a few studies [18]. In a cross-sectional study, Chaiard et al. [19] reported that work schedules including more than 10 night shifts per month were associated with difficulty initiating sleep among nurses; however, the impacts of various components of shift work on nurses' sleep have not been fully elucidated.

Härmä et al. [20] aimed to evaluate health problems among nurses by examining 4 work patterns using data from the electronic work hour databases of various hospitals. They suggested measurement indices for the time of day of the work, hours worked, shift intensity, and social aspects of working hours. In reference to this study, Yoon et al. [21] proposed specific work hour indices. In particular, based on 2 indices of shift-work intensity (the number of 3 consecutive night shifts and the number of short recovery periods) they proposed an evaluation method to better reflect the situation in Korea.

Shin and Kim [22] reported that working 3 consecutive night shifts was associated with insomnia among hospital nurses. In that study, few Korean studies have been conducted on the relationship between the intensity of shift work and symptoms of insomnia; however, in one example, they used actigraphy to evaluate changes in sleep indices over 6 days according to the time of the day during which the nurse worked. Thus, that study had a limited capacity to explain the relationship between shift work schedules and clinically significant insomnia symptoms.

The purpose of the current study was to investigate the association between the intensity of shift work and reports of insomnia symptoms among nurses working at a university hospital to provide a foundation for establishing policies on work schedule design for health of nurses.

METHODS

Study Participants

The participants of this study were female nurses working rotating shifts at a university hospital. These nurses underwent a special medical examination for night shift workers, as well as a general medical examination, in 2015. In Korea, the Occupational Safety and Health Act requires employers to provide general medical examinations to all workers and special medical examinations to those who work under hazardous conditions. A special medical examination for night shift workers has been implemented to combat health problems such as sleep disorders, cerebrovascular and cardiovascular disease, and breast cancer among these workers. This study included nurses who had worked at least 1 night shift within the 3 months prior to the special medical examination, and a total of 386 participants were included in the analysis.

Main Variables

Independent variables

To assess shift work intensity, the aforementioned indices developed by Yoon et al. [21] were used. Values were calculated using data on individual work schedules, collected for the evaluation of exposure to harmful factors as part of the preliminary investigation in the special medical examinations for night shift workers. Computerized personal work schedule data, where the individual type of work is assessed daily, coded (as night, daytime, evening, or off duty) were used to investigate each individual's work schedule for the 3 months prior to the medical examination. A short recovery period was defined by Yoon et al. [21] as including night-off-day, night-off-evening, and evening-off-day work schedules.

In the present study, the number of 3 consecutive night shifts and the number of short recovery periods over the past 3 months were used as 2 separate variables of shift work intensity. Both variables had potential values of 0, 1 to 2, and 3 or more. The Supplemental Material 1 shows the distributions of both observations of variables.

Dependent variables

Data on insomnia symptoms were extracted from the database used for the special medical examination for night shift workers. The medical examination data were used to assess the symptoms of insomnia based on the Korean Insomnia Severity Index (ISI), which is a version (translated by Cho et al.

[23]) of the original index developed by Bastien et al. [24]. The ISI includes a total of 7 questions, and the total score is calculated by summing the scores of the questions (0-4 points for each). A higher score indicates a greater severity of insomnia symptoms. Since an ISI score of 8 is used to indicate minor insomnia, insomnia symptoms were considered to be present for an ISI score of 8 or greater and absent for a score of less than 8. The Supplemental Material 2 shows the distribution of ISI score.

Confounding variables

Confounding variables included age, employment duration, number of hours worked, work department, amount of exercise, and level of alcohol consumption. Age and employment duration data were extracted from a special medical examination database; total time worked over the past 3 months and work department data were obtained from the aforementioned computerized work schedule database; and information on lifestyle habits, such as exercise and alcohol consumption, were extracted from a general medical examination database. Work hours were measured as the prescribed work hours, according to the employment rules or labor contracts within the legal standard of work hours. Among the study participants, the prescribed work hours were 8 hours for morning and afternoon shifts, 9.5 hours for night shifts, and 30 minutes of hand-off time per shift. However, we were unable to collect information on the pre-work time associated with the preparation of goods, medicines, and treatment tools or time spent processing delayed work during work hours.

The work department was defined as either a special sector (the operating room, recovery room, emergency room, and intensive care unit) or the general ward. The information on lifestyle habits extracted from the general medical examination database was classified according to the 2018 counseling manual of National Health Screening Program provided by the Korean Centers for Disease Control and Prevention [25].

With regard to alcohol consumption, participants were classified as non-drinkers, light drinkers, moderate drinkers, or heavy drinkers. The evaluation of alcohol consumption was based on the report [25], which referred to the guidelines [26] of the National Institute on Alcohol Abuse and Alcoholism in the United States. The report was referred by the Korean guidelines established by Lee et al. [27] in 2019.

Among female younger than 65 years, light drinkers were

defined as those who did not consume more than 4 drinks per week or 2 drinks on 1 occasion. Those who consumed more than 5 drinks on 1 occasion or 7 drinks per week were considered heavy drinkers. Moderate drinkers were those whose consumption habits fell between those of light and heavy drinkers.

The amount of exercise was categorized as low, moderate, or high. The classification criteria were as follows: low exercise, less than 150 minutes (2 hours and 30 minutes) of aerobic activity per week; high exercise, more than 300 minutes (5 hours) of medium-intensity aerobic activity performed 3-5 times per week; and moderate exercise, an amount between low and high exercise. This classification was based on the 2008 Physical Activity Guidelines for Americans [28], which are also reflected in the guidelines of Kim et al. [29].

Statistical Analysis

Stata SE version 16.1 (StataCorp., College Station, TX, USA) was used for statistical analysis. The distribution of each variable was presented for each group of participants: that is, the group with insomnia and the group without insomnia. The independent *t*-test was performed for continuous variables, including age, employment duration, and total time worked over the prior 3 months, to evaluate the differences between the 2 groups. For work department, the number of 3 consecutive night shifts, and the number of short recovery periods, the chi-square test was conducted with each of the latter 2 parameters classified as 0, 1 or 2, or 3 or more times.

To clarify the relationship between the intensity of shift work and insomnia symptoms, odds ratios (ORs) were calculated using univariate analysis, and multiple logistic regression analysis adjusted for confounding variables was performed. The confounding variables included were age, alcohol consumption, amount of exercise, employment duration, work department, and total time worked over the past 3 months. Furthermore, an interaction analysis was performed to determine whether statistically significant interactions between independent variables were present.

Ethics Statement

This study was approved by the Institutional Review Board of Ewha Womans University Mokdong Hospital (EUMC 2018-05-017).

RESULTS

Characteristics of Study Participants and Symptoms of Insomnia

On average, the nurses in the group with insomnia symptoms were statistically significantly younger than those in the group without symptoms (31.9 ± 5.6 vs. 33.2 ± 6.2 years, respectively; $p=0.029$). The number of total time worked over the past 3 months was statistically significantly higher among the group with insomnia symptoms than among the group without symptoms (458.6 ± 30.1 vs. 446.7 ± 49.1 hours, respectively; $p=0.006$). Seventy nurses (32.6%) in the group without insomnia symptoms and 33 (19.3%) in the group with insomnia symptoms had not worked 3 consecutive night shifts; 96 nurses (44.7%) in the former group and 70 (40.9%) in the latter group had done so 1-2 times; and 49 nurses (22.8%) in the former group and 68 (39.8%) in the latter group had done so at least 3 times, indicating that the presence of insomnia symptoms tended to be associated with a greater number of these shifts ($p<0.001$). Regarding short recovery periods, 70 participants (32.6%) in the group without insomnia symptoms and 36 (21.1%) in the group with insomnia symptoms had experienced no such recovery periods in the past 3 months; 100 participants (46.5%) in the former group and 84 (49.1%) in the latter group had experienced 1-2 instances; and 45 participants (20.9%) in the former group and 51 (29.8%) in the latter group had experienced 3 or more instances of short recovery periods, which suggests that the presence of insomnia symptoms tended to be associated with a greater number of short recovery periods ($p=0.021$). The mean employment duration was not statistically significantly different between the groups and no significant intergroup difference was observed with regard to work department, alcohol consumption, or exercise (Table 1).

Relationship Between Shift Intensity and Insomnia Symptoms

In the univariate analysis (Table 2), the OR for insomnia symptoms for 3 consecutive night shifts over the past 3 months was 1.55 (95% confidence interval [CI], 0.92 to 2.59) for those who had experienced 1-2 instances and 2.94 (95% CI, 1.69 to 5.12) for those who had experienced 3 or more instances, relative to those who had not worked any such shifts. In the multiple logistic regression analysis adjusted for age, employment duration, total time worked over the past 3 months, alcohol consumption,

Table 1. Characteristics of the study population

Characteristics	Insomnia		p-value
	No (n=215) < 8 score	Yes (n=171) ≥ 8 score	
Age (y)	33.2 ± 6.2/ [25, 28]	31.9 ± 5.6/ [26, 51]	0.029 ¹
Duration of employment (y)	6.9 ± 5.6/ [1, 32]	6.0 ± 5.8/ [1, 29]	0.140 ¹
Total time worked over the past 3 mo (hr) [min, max]	446.7 ± 49.1/ [83, 517]	458.6 ± 30.1/ [337, 511]	0.006 ¹
Department ³			0.247 ²
General ward	132 (61.5)	95 (55.6)	
Special sector ⁴	83 (38.6)	76 (44.4)	
Alcohol consumption			0.208 ²
None	103 (47.9)	68 (39.8)	
Light	40 (18.6)	30 (17.5)	
Moderate	46 (21.4)	41 (24.0)	
Heavy	26 (12.1)	32 (18.7)	
Amount of exercise			0.218 ²
High	102 (47.4)	83 (48.5)	
Moderate	64 (29.8)	39 (22.8)	
Low	49 (22.8)	49 (28.7)	
No. of 3 consecutive night shifts during the past 3 mo			<0.001 ²
0	70 (32.6)	33 (19.3)	
1-2	96 (44.7)	70 (40.9)	
≥ 3	49 (22.8)	68 (39.8)	
No. of short recovery periods after the previous shift during the past 3 mo			0.021 ²
0	70 (32.6)	36 (21.1)	
1-2	100 (46.5)	84 (49.1)	
≥ 3	45 (20.9)	51 (29.8)	

Values are presented as mean ± standard deviation/[minimum, maximum] or number (%).

¹Independent t-test; dependent t-test.

²Pearson chi-square test.

³Department of the hospital.

⁴Includes the operating room, intensive care unit, recovery room, and emergency department.

and exercise, the OR was 1.37 (95% CI, 0.80 to 2.35) for those who had worked 1-2 shifts and 2.33 (95% CI, 1.29 to 4.20) for those who had worked 3 or more shifts, compared to those who had not worked any such shifts.

Regarding short recovery periods, in the univariate analysis, the OR for insomnia symptoms was 1.63 (95% CI, 0.99 to 2.68) for those who had experienced 1-2 short recovery periods over the past 3 months and 2.20 (95% CI, 1.25 to 3.89) for those who had experienced 3 or more, relative to those with no short recovery periods. In the multiple logistic regression analysis ad-

Table 2. Association of shift intensity with insomnia among hospital nurses in 2015 (n=386)

Variables	Crude model	Adjusted model ¹
Age	0.96 (0.93, 1.00)	0.94 (0.86, 1.02)
Duration of employment	0.97 (0.94, 1.01)	1.05 (0.97, 1.15)
Total time worked	1.01 (1.00, 1.01)	1.00 (1.00, 1.01)
Department ²		
General ward	1.00 (reference)	1.00 (reference)
Special sector ³	1.27 (0.85, 1.91)	1.41 (0.89, 2.22)
Alcohol consumption		
None	1.00 (reference)	1.00 (reference)
Light	1.14 (0.65, 2.00)	1.14 (0.62, 2.09)
Moderate	1.35 (0.80, 2.27)	1.10 (0.63, 1.93)
Heavy	1.86 (1.02, 3.40)	1.48 (0.78, 2.83)
Amount of exercise		
High	1.00 (reference)	1.00 (reference)
Moderate	0.75 (0.46, 1.22)	0.82 (0.49, 1.38)
Low	1.23 (0.75, 2.01)	1.35 (0.81, 2.27)
No. of 3 consecutive night shifts during the past 3 mo		
0	1.00 (reference)	1.00 (reference)
1-2	1.55 (0.92, 2.59)	1.37 (0.80, 2.35)
≥3	2.94 (1.69, 5.12)	2.33 (1.29, 4.20)
No. of short recovery periods after the previous shift during the past 3 mo		
0	1.00 (reference)	1.00 (reference)
1-2	1.63 (0.99, 2.68)	1.45 (0.85, 2.47)
≥3	2.20 (1.25, 3.89)	2.01 (1.08, 3.73)

Values are presented as odds ratio (95% confidence interval).

¹Adjusted for age, duration of employment, total time worked over the past 3 months, department, alcohol consumption, and exercise.

²Department of the hospital.

³Includes the operating room, intensive care unit, recovery room, and emergency department.

justed for the aforementioned confounding variables, the OR was 1.45 (95% CI, 0.85 to 2.47) for nurses with 1-2 short recovery periods and 2.01 (95% CI, 1.08 to 3.73) for those with 3 or more, relative to those with no short recovery periods (Table 2).

In the analysis of the model with respect to interactions among the independent variables, no statistically significant interactions were observed.

DISCUSSION

The overall prevalence of insomnia symptoms in this study was 46.5%. In previous studies, the prevalence of insomnia symptoms among nurses working rotating shifts has ranged from 34.3% to 55.0% [30-32]. As each study used a different

classification system for insomnia symptoms, the differences in prevalence among the studies were notable [33]. Therefore, it is difficult to directly compare the prevalence rate found in the current study with those of previous studies.

In the current study, the intensity of shift work was an independent factor associated with an increased risk of insomnia symptoms among rotating shift nurses. In particular, we found that the risk increased approximately 2.3-fold if participants worked 3 consecutive night shifts more than once a month and more than 2.0-fold if a short recovery period was experienced more than once a month, after adjustment for major confounding variables. These findings align with those of a recent study. In 2018, Härmä et al. [34] conducted a follow-up study of 7727 nurses and reported that the ORs for fatigue and difficulty falling asleep were significantly greater among those who had experienced a higher frequency of short shift intervals and shifts on 3 consecutive nights.

In this study, we confirmed the association between the number of 3 consecutive night shifts as an index of the intensity of shift work, and an increased risk of insomnia symptoms. Ergonomics textbooks similarly recommend limiting consecutive night work to 2 days. In 1976, Knauth and Rutenfranz [35] conducted an experimental study on shift work and circadian rhythm. They reported that the circadian rhythm recovered within 2 days after the end of a night shift. Although experimental studies have yielded the suggestion that consecutive night shifts should be limited to 2 days, few studies have actually been conducted to investigate the relationship between shift work schedule and health problems in shift workers. Our study provides a more robust basis for the guidelines that nurses' work schedules should be designed to prevent shifts on 3 consecutive nights in order to protect their health.

Ensuring an adequate recovery period is important when aiming to design healthy work schedules for nurses. In the abovementioned 2018 study by Härmä et al. [34], a short recovery period was defined as an interval of less than 11 hours between shifts, and its association with various health indicators, including sleep-onset disorder, was reported. In 2013, Eldevik et al. [3] demonstrated that an increased risk of insomnia was associated with a higher frequency of "quick returns," defined as less than 11 hours off work between shifts, over a period of a year in a study of 5400 Norwegian nurses. Otherwise, however, the effect of short recovery periods on the health of nurses performing rotating shift work has been rarely researched.

The International Labor Organization recommends that the interval between work shifts should be 11 hours or more [36]. Thus, an interval of less than 11 hours between shifts can be considered an extremely short recovery period. As our study included very few cases in which the interval between shifts was less than 11 hours, we used work schedule types to define a short recovery period, referring to insights from a worksite interview conducted by Choi [37] in 2018. An excerpt of that oral interview is given below:

On the last day of a 3-night shift, it feels like my body is literally breaking down... when the night shifts were reduced from 3 to 2, we felt better, it was good, but the night-off-evening and night-off-off-day work schedules are still too much to handle.

Choi [37] conducted a mixed-methods study involving ward nurses. In that study, a short recovery period was described as inducing physical and mental impairment and the researchers found that increased work intensity exacerbated these risks in the context of routine excessive overtime. Similarly, we calculated an index of short recovery period that reflected real-world conditions and provided a basis for establishing concrete measures to reduce the health risk. This demonstrates that a study reflecting actual field experience can be useful to derive practical solutions for this problematic situation.

A relatively new approach is necessary to establish an evaluation method for shift work intensity. In the study by Härmä et al. [34], the measurement period for the intensity of shift work in relation to fatigue and sleep-onset disorder was 3 months. The variables for shift intensity used in our study were also calculated using data from the 3 months prior to each individual's medical examination. This method includes a sufficient exposure period to allow clinically meaningful insomnia symptoms to arise and it takes into account the characteristics of the actual work schedules of nurses. In general, the intensity of shift work may increase among nurses working in general hospitals in Korea when department members are restricted from working at night due to pregnancy or childbirth or when a workforce reduction occurs due to parental leave or resignation. Furthermore, it was assumed that vacant positions are typically filled within 3 months and that high-risk schedules, such as those involving 3 consecutive night shifts, are not assigned every month. Ropponen et al. [38] conducted a case-crossover study on the relationship between the intensity of shift work and sick leave taken by nurses. In that study, the intensity of shift work was assessed by calculating the number of shifts involving 2 or 4 consecutive nights within a 4-week period. Like-

wise, the method of evaluation of shift work intensity may differ. Therefore, in the future, measurement methods should be explored in various contexts to confirm the association of shift work intensity with health problems.

The limitations of this study are as follows. First, it was cross-sectional in nature. Thus, the presence of a causal relationship between the intensity of shift work and symptoms of insomnia could not be ascertained based on the study results alone. However, insomnia symptoms were reported on the day of the health examination, and the independent variables used were shift work intensity indices calculated for the 3-month period prior to the examination. In other words, given that the exposure temporally preceded the health outcome, a causal relationship certainly is possible. Second, various harmful factors and health status variables that can relate to insomnia symptoms were not examined. In previous studies, personal factors such as anxiety and depression [32], chronotype [39] were found to be associated with insomnia symptoms. If the effects of these factors are taken into consideration, the magnitude of the association between shift work intensity and insomnia observed in this study may be reduced. This limitation should be addressed in prospective follow-up research. Third, shift work intensity and hours worked were assessed using a computerized work schedule database. Since hours worked were defined as prescribed work hours, the numbers of actual work hours could have been greater. This is a non-discriminatory misclassification, and as the number of hours worked was a confounding variable, its effect on the association between shift-work intensity and insomnia symptoms is unlikely to have been meaningful. Fourth, the presence of insomnia symptoms was investigated through participants' self-reports. However, we used structured indices that had been verified in several prior studies and that the subjective quality of sleep perceived by an individual is also important in assessing sleep health.

The significance of this study is that shift work intensity was assessed through objective indicators and its association with insomnia symptoms was suggested, which is particularly noteworthy given that research on this topic is limited. To the best of our knowledge, this is the first Korean study to investigate the relationship between indicators of shift work intensity and health problems using objective data regarding the intensity of shift work.

In terms of government policy, our findings suggest the need to work to prohibit or at least reduce shifts on 3 consecu-

tive nights, given that not only the frequency but also the distribution of night work is important in rotating shift work. In addition, shift workers should be provided with adequate sufficient recovery periods especially after night work and evening work. In qualitative studies, short recovery periods (described as night–off–evening, night–off–day, and evening–off–day schedules) have been reported by nurses in the field to be a major burden, and such short periods were found to increase the risk of insomnia symptoms in our study.

Furthermore, as designing a reasonable work schedule for nurses without increasing the number of staff is practically impossible, the problem may not be overcome at the level of individual hospitals. In particular, in Korea, where the private sector accounts for 90% of the total healthcare system and public institutions play only a partial role, the recruitment of nursing personnel requires intervention at the national level. Reducing the intensity of shift work among nurses is not only necessary for the protection of their health, but also related to the health and safety of the public.

SUPPLEMENTAL MATERIALS

Supplemental materials are available at <https://doi.org/10.3961/jpmph.20.555>.

CONFLICT OF INTEREST

The authors have no conflicts of interest associated with the material presented in this paper.

FUNDING

None.

ACKNOWLEDGEMENTS

None.

AUTHOR CONTRIBUTIONS

Conceptualization: YC. Data curation: JHP, SY. Formal analysis: YC. Methodology: JHP, DHK, HK. Funding acquisition: None. Writing - original draft: YC. Writing - review & editing: YC, HK, SY, JHP, DHK.

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