

## ORIGINAL ARTICLE

# Relationship between insomnia and rest time between shifts among shift workers: A multicenter cross-sectional study

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## Abstract

**Objectives:** A rest time of less than 11 h taken by a shift worker between shifts is defined as quick return (QR). QR is shown to decrease sleep time by virtue of decreasing rest time, diminishing sleepiness and exhaustion, and increasing the number of sick days taken by employees. Therefore, in this multicenter retrospective study, the association between QR and the incidence of insomnia was established using the night-shift questionnaire from the Korean Workers Health Examination-Common Data Model.

**Methods:** Three hospitals collected the night-shift profiles and baseline demographic data of 33 669 workers between January 2015 and December 2017. The most recent date of examination was used for participants who had been examined multiple times at the same institution. We used multiple logistic regression to calculate the odds ratios (ORs) and 95% confidence intervals (CIs). The pooled ORs were estimated using combined results from the three institutions.

**Results:** The proportion of men was higher than that of women in the QR group at each institution. The pooled ORs were computed using combined data from the three institutions. Workers who reported a QR had the highest risk of sleeplessness (OR, 1.21; 95% CI, 1.12–1.31) compared to those workers who reported a slow return, after adjusting for possible confounders.

Juho Sim and Byungyoon Yun contributed equally and are considered co-first authors.

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**Conclusions:** A substantial correlation was established between QR and insomnia using the CDM approach and data from multiple centers. This study may serve as a foundation for developing guidelines to enhance the health of shift workers and prevent occupational accidents.

**KEYWORDS**

common data model, insomnia, quick return, rest time between time, shift workers

## 1 | INTRODUCTION

Sleep is among the basic human needs and constitutes an essential part of physical and mental health. It plays an important role in restoring the energy consumed during active hours and not only helps in improving cognitive functions such as memory but also is essential for maintaining metabolic and endocrine function.<sup>1-3</sup>

Insomnia is a type of sleep disorder, which refers to symptoms arising from sleep deprivation. It has a deleterious effect on the quality of life, such as decreased productivity and impaired mood states. In the United States of America, the total estimated direct or indirect medical cost incurred due to insomnia was \$100 billion per year.<sup>4,5</sup> The economic burden and health-care considerations for the treatment of insomnia, sleep deprivation, and circadian disturbances that can affect physical and mental health are higher for shift workers who work irregular hours than for daytime workers.<sup>6</sup> Approximately 10% of American workers have sleep problems and drowsiness due to shift work,<sup>7</sup> and approximately 55% of their Korean counterparts were found to experience insomnia.<sup>8</sup>

Rest time between shifts is an important factor that influences the health of shift workers. In Europe, guidelines have been established to ensure a minimum break of 11 consecutive hours per day.<sup>9</sup> Quick return (QR) is defined as the condition where a worker fails to follow these guidelines and takes a shorter break of less than 11 consecutive hours between the end of one shift and the start of the next.<sup>10</sup> QR has been found to be especially prevalent in the medical field. According to a study of Swedish doctors, 64% had QR,<sup>11</sup> while another study reported QR in 81% of Norwegian nurses.<sup>12</sup>

QR was found to reduce sleep time by shortening the rest time, negatively affecting drowsiness and fatigue,<sup>10</sup> and increasing the number of sick days required by workers.<sup>13</sup> Furthermore, QR has been shown to negatively influence daily memory.<sup>14</sup> However, most studies regarding QR and its effect on sleep were for nurses, and female predominant. On contrary, there were few studies about QR among whole industries with similar gender prevalence.

Therefore, this study aimed to elucidate the relationship between QR and the prevalence of insomnia among

diverse industries by incorporating a multicenter retrospective design and using night-time questionnaires provided in the Korean Workers Health Examination-Common Data Model (KWHE-CDM).

## 2 | MATERIALS AND METHODS

### 2.1 | Study population

Common data model (CDM) is found on the notion of transforming data included inside various databases into a standardized format (data model) and representation and then performing systematic analyses utilizing a library of standard analytic procedures written in the common format. Each institution converts a dataset of a different format into a dataset of the same variable and value mainly according to Observational Medical Outcomes Partnership's Common Data Model, which is one of the representative CDM.<sup>15</sup> This method could facilitate the academic interaction among research institutions.

The KWHE-CDM was implemented in five medical institutions that perform specialized health examinations, three of which participated in this study. Each institution voluntarily participated in this project. The KWHE-CDM dataset comprises general measurements, common questionnaires, customized questionnaires, and questionnaires for night-shift workers. Data of night shift workers were collected through specialized health examinations, and all the questionnaires and measurements were performed at the time of health examination. Data of night shift workers, including night shift profiles and baseline demographics, and insomnia, were collected according to the response of the questionnaires performed between January 2015 and December 2017. The most recent examination date was used for participants who had undergone multiple examinations at the same institution. For reference, these data were collected before the COVID-19 pandemic.

A total of 13 311 participants were recruited from Sinchon Severance Hospital, 6429 from Wonju Severance Hospital, and 13 929 from Ulsan University Hospital (total number of workers: 33 669). The same analysis was

performed using the equivalent statistical syntax at each medical facility, which ensured that comparable results were obtained using the CDM approach.

## 2.2 | Procedure

The primary endpoint of this study was the presence of insomnia. This study utilized the insomnia severity index (ISI) questionnaire, which is a helpful, widely used, and valid survey instrument that is used to quantify the severity of insomnia<sup>16</sup> and has been validated in Korea.<sup>17</sup> Each ISI question is scored on a 5-point Likert scale, producing a total score ranging between 0 and 28. Participants were classified into the following four categories based on their ISI score: 0–7 (no insomnia), 8–14 (sub-threshold insomnia), 15–21 (moderate insomnia), and 22–28 (severe insomnia).<sup>18</sup> The absence of insomnia was designated as the non-insomnia group, while sub-threshold, moderate, and severe insomnia were designated as the insomnia group.

Workers whose work entailed less than 11 h between the end of the shift and the start of the next shift were defined as having QR by the questionnaire. The others were classified into the “slow return” (SR) group. The questionnaire was about the ordinary experience past 6 months at the time of the survey.

Covariates for the multivariable analysis were derived from the baseline demographic information (age and gender) and additional night-shift characteristics, including weekly work hours and consecutive night shift work. The night-shift characteristics of the individuals in the CDM dataset were obtained from the night-time questionnaire surveys. The working-hour covariates included whether or not workers worked for 52 h or more per week on average. The number of consecutive night shifts was determined by the response to the question “How many consecutive night shifts did you normally work in the last year?” on the following 5-point Likert scale: none, two days, three days, four days, and five or more days.

## 2.3 | Statistical analysis

Differences between the examinees with and without insomnia were determined using the independent *t*-test for continuous data and chi-square test for categorical data. The proportion of participants' occupation was calculated. Odds ratios (OR) and 95% confidence intervals (CIs) for insomnia were calculated using the multiple logistic regression model. A range of covariates, including the baseline characteristics and night shift-related variables, were adjusted in the logistic regression models. The data

from each hospital were examined using comparable statistical approaches.

A meta-analysis was conducted to corroborate the integrated results based on the results of the logistic regression of each organization. The standard error weight was used to calculate the pooled ORs and 95% CIs for insomnia.

All statistical analyses were two-sided;  $P < .05$  denoted statistical significance. All statistical analyses were conducted using R version 4.1.0 (R Foundation for Statistical Computing, Vienna, Austria).

## 2.4 | Ethics statement

The Institutional Review Board of Severance Hospital authorized the study protocol, which adhered to the ethical standards of the Declaration of Helsinki of 1975 (IRB identification number: Y-2020-0011). The need for obtaining informed consent from the participants was waived, owing to the retrospective nature of this study.

## 3 | RESULTS

Table 1 summarizes the information of the participants from each institution. The total number of employees in the QR group (QR: less than 11 h) was 3285 and that in the SR group (SR: more than 11 h) was 10 028 at institution 1. Men accounted for over half (55.6%) of the employees in the QR group and 48.9% of the SR group, with statistically significant differences ( $P < .001$ ). Statistically significant variations were observed between the average ages ( $36.1 \pm 9.53$  years vs.  $38.0 \pm 10.3$  years) of the participants of the QR and SR groups. The proportion of workers who worked for more than 52 h a week was 58.1% in the QR group compared to 20.8% in the SR group, and the difference was statistically significant ( $P < .001$ ). The percentage of respondents who answered “none” (22.4%) and “2 nights” (13.0%) to the question on consecutive night-shift work was higher in the QR group than in the SR group (none, 14.6%; 2 nights, 9.4%; 3 nights, 16.4%; 4 nights, 13.0%; and more than 5 nights, 46.6%), while the percentage of respondents who answered “3 nights” (13.9%), “4 nights” (4.7%), and “more than 5 nights” (46.0%) was lower in the QR group, with statistically significant differences ( $P < .001$ ). The frequency of insomnia (as measured by the ISI questionnaire) was 47.4% in the QR group, which was significantly higher than that in the SR group (42.5%) ( $P < .001$ ).

The number of employees from institution 2 was 1528 in the QR group and 4901 in the SR group. Women accounted for 40.4% of the QR group and 35.1% of the SR group, and the disparity between them was statistically

TABLE 1 Basic characteristics of each institution with respect to rest time between shifts

	Institution 1		Institution 2		Institution 3		P-value	P-value
	Quick return (N = 3285)	Slow return (N = 10028)	Quick return (N = 1528)	Slow return (N = 4901)	Quick return (N = 2762)	Slow return (N = 11167)		
Gender								
Female	1458 (44.4%)	5124 (51.1%)	618 (40.4%)	1718 (35.1%)	306 (11.1%)	1305 (11.7%)	<.001	.390
Male	1827 (55.6%)	4904 (48.9%)	910 (59.6%)	3183 (64.9%)	2456 (88.9%)	9862 (88.3%)		
Age								
Mean $\pm$ SD	36.1 $\pm$ 9.53	38.0 $\pm$ 10.3	41.5 $\pm$ 11.8	44.3 $\pm$ 12.6	45.1 $\pm$ 11.6	43.1 $\pm$ 11.4	<.001	<.001
Median [min, max]	33.0 [19.0, 69.0]	36.0 [19.0, 69.0]	40.0 [20.0, 79.0]	44.0 [20.0, 85.0]	46.0 [18.0, 76.0]	44.0 [19.0, 73.0]		
Working hours								
Under 52 h	1376 (41.9%)	7938 (79.2%)	824 (53.9%)	2946 (60.1%)	2021 (73.2%)	9492 (85.0%)	<.001	<.001
Over 52 h	1909 (58.1%)	2090 (20.8%)	704 (46.1%)	1955 (39.9%)	741 (26.8%)	1675 (15.0%)		
Consecutive night shifts								
None	735 (22.4%)	1463 (14.6%)	283 (18.5%)	1743 (35.6%)	728 (26.4%)	2286 (20.5%)	<.001	<.001
2 nights	427 (13.0%)	943 (9.4%)	318 (20.8%)	842 (17.2%)	189 (6.8%)	555 (5.0%)		
3 nights	455 (13.9%)	1648 (16.4%)	210 (13.7%)	695 (14.2%)	234 (8.5%)	800 (7.2%)		
4 nights	156 (4.7%)	1300 (13.0%)	81 (5.3%)	203 (4.1%)	301 (10.9%)	3026 (27.1%)		
5 or more nights	1512 (46.0%)	4674 (46.6%)	636 (41.6%)	1418 (28.9%)	1310 (47.4%)	4500 (40.3%)		
ISI								
Insomnia	1558 (47.4%)	4260 (42.5%)	595 (38.9%)	1563 (31.9%)	1055 (38.2%)	3995 (35.8%)	<.001	.019
Non-insomnia	1727 (52.6%)	5768 (57.5%)	933 (61.1%)	3338 (68.1%)	1707 (61.8%)	7172 (64.2%)		

Note: Abbreviation: ISI: insomnia severity index

significant ( $P < .001$ ). Statistically significant variations were observed between the average ages ( $41.5 \pm 11.8$  years vs.  $44.3 \pm 12.6$  years) of the participants of the QR and SR groups ( $P < .001$ ). The response rate for working hours exceeding 52 h a week was 46.1% in the QR group, which was significantly higher than the response rate of 39.9% in the SR group ( $P < .001$ ). The responses for consecutive night-shift work were as follows: 18.5% and 35.6% for “none,” 20.8% and 17.2% for “2 nights,” 13.7% and 14.2% for “3 nights,” 5.3% and 4.1% for “4 nights,” and 41.6% and 28.9% for “5 or more nights” in the QR and SR groups respectively. The differences between the responses among the QR and the SR groups for “3 nights,” “4 nights,” and “5 or more nights” were statistically significant ( $P < .001$ ). The prevalence of insomnia was 38.9% in the QR group, which was significantly higher than 31.9% in the SR group ( $P < .001$ ).

At institution 3, the QR and SR groups consisted of 2762 and 11 167 participants, respectively. Women accounted for 11.1% of the participants in the QR group and 11.7% of the SR group, but the difference lacked statistical significance ( $P = .390$ ). The mean age of the participants of the QR group ( $45.1 \pm 11.6$  years) was significantly higher than that of the SR group ( $43.1 \pm 11.4$  years) ( $P < .001$ ). The response rate of the QR group for working over 52 h in a week was 26.8%, which was significantly higher than that of the SR group (15.0%) ( $P < .001$ ). The frequency of consecutive night-shift work in the QR group was 26.4%, 6.8%, and 8.5% for “none,” “2 nights,” and “3 nights,” respectively, which was higher than the corresponding responses of 20.5%, 5.0%, and 7.2% in the SR group. The frequency of consecutive night-shift work for “4 nights” was lower in the QR group (10.9%) than in the SR group (27.1%), and for “more than 5 nights,” the frequency was higher in the QR group (47.4%) than in the SR group (40.3%), and this difference was statistically significant ( $P < .001$ ). The frequency of insomnia (as measured by the ISI questionnaire) was 38.2% in the QR group, which was significantly higher than that in the SR group (35.8%) ( $P = .019$ ).

The proportion of participants' occupation in each institution is summarized in Supplementary Table S1. The most prevalent occupation was manufacture field (42.02% of the entire population; 30.46% of institution 1, 21.57% of institution 2, and 62.51% of institution 3). There were also other various occupations including human health activities, information and communication, accommodation and food service activities, and business facilities management and business support services; rental and leasing activities.

Pooled ORs were computed using the combined data from the three institutions (Table 2). The pooled ORs revealed that the variables influencing insomnia included gender, age, consecutive night shifts, and rest time

TABLE 2 Insomnia prevalence pooled odds ratio by rest time between shifts

	Model 1	Model 2
Gender		
Male	(reference)	(reference)
Female	<b>1.25 (1.19–1.32)</b>	<b>1.16 (1.06–1.27)</b>
Age	0.99 (0.98–1.00)	0.99 (0.98–1.00)
Working hours		
Under 52hrs		(reference)
Over 52hrs		1.16 (0.97–1.39)
Consecutive		
None		(reference)
2 nights		<b>1.83 (1.48–2.25)</b>
3 nights		<b>2.77 (2.07–3.70)</b>
4 nights		<b>1.80 (1.48–2.19)</b>
Over 5 nights		<b>1.78 (1.57–2.03)</b>
Rest time between shifts		
<b>Slow return</b>	<b>(reference)</b>	<b>(reference)</b>
<b>Quick return</b>	<b>1.20 (1.11–1.29)</b>	<b>1.21 (1.12–1.31)</b>

Note: Model 1: gender, age.

Model 2: gender, age, working hours, consecutive night shifts.

Bold shows the statistical significance of the ORs.

between shifts. Model 1 was adjusted for variables such as age and gender, and Model 2 was adjusted for age, gender, working hours, and consecutive night shifts. When compared to SR, all responses associated with QR were correlated with insomnia in Model 2. The OR of QR was 1.21 (95% CI, 1.12–1.31) compared to SR. Furthermore, consecutive night shifts were significantly associated with insomnia, and the highest OR was 2.77(95% CI, 2.07–3.70) in three consecutive night shift, compared to “none.” Supplementary Table S2 contains the completed version of the multiple logistic regression model for each institution.

## 4 | DISCUSSION

The results of this study showed that the correlation between the prevalence of insomnia and QR retained its statistical significance even after adjusting for covariates including gender, age, working hours, and consecutive night-shift work, which were found to be related to QR. Several previous studies have revealed the relationship between QR and insomnia, which was reinforced by this study.<sup>10,11,19</sup>

According to other studies, QR reduced the sleep time of shift workers, caused drowsiness during work, induced awakening during sleep, and attention



disturbance during work.<sup>20-23</sup> Although it was not confirmed in this study, QR was correlated with workplace accidents in previous studies.<sup>24,25</sup> Both QR and night shifts were associated with workplace accidents,<sup>24</sup> and an increase in QR was found to be related to a surge in occupational accidents.<sup>25</sup> Several previous studies showed that QR was associated with insomnia, which may lead to an increase in the occurrence of industrial accidents.<sup>26</sup>

Therefore, it is thought that the reduction in QR can reduce the occurrence of insomnia and, consequently, lower the frequency of industrial accidents, which would reduce the social cost of accidents related to insomnia (\$32 062).<sup>27</sup> Additionally, QR was found to be related to the occurrence of disease.<sup>28</sup> Hence, QR is related not only to insomnia but also to pain and disease and can be inferred as a very important factor affecting the health of shift workers.

Moreover, consecutive night shifts were also significantly related to insomnia. Consecutive night shifts were known to be associated with sleep duration and sleep quality.<sup>29</sup> Likewise, consecutive night shifts are also thought to cause insomnia by worsening sleep duration and sleep quality rather than directly affecting insomnia. Therefore, to prevent insomnia, a consecutive night shift strategy is required that can improve sleep time and sleep quality.

In this study, the proportion of women with insomnia was 1.25 times higher than that of men, after adjusting for QR and age. Most studies focusing on QR and insomnia were conducted on nurses, who were mostly women.<sup>24,30,31</sup> Another study conducted in Korea focused only on hospital personnel, and most participants were women.<sup>28</sup> As such, there are many studies with a high frequency of women due to the nature of their jobs, but in this study, the frequency of men and women is similar, including various occupations.

Furthermore, according to a study that used data from the Korea National Health Insurance Corporation cohort, the incidence and prevalence of insomnia were higher in women than in men<sup>32</sup>; another study that used data from special health examinations for night shift workers also revealed that the prevalence of insomnia was higher in women than in men.<sup>33</sup> Therefore, as observed in this study, the higher frequency of insomnia in women than in men in studies using hospital data is an important result.

Our study has several strengths. First, it was a multicenter study focused on workers from various occupational fields, including machinery operators, health-care workers, and manufacturing workers. Given that previous studies usually focused on hospital workers,<sup>14,31,34</sup> the findings of this study enabled generalization of the association between QR and insomnia to other fields. Moreover, in our study, a large number of participants were recruited using the CDM distribution methodology. Pooled ORs

were calculated from the OR of each institution derived from the same statistical syntax, thus maintaining the security of the personal data of each participant.

In contrast, several limitations of our study should also be considered. First, it was a cross-sectional study, which could not clarify the temporal and frequency relationship between QR and insomnia. However, the questionnaires inquired about the night-shift profile over the past year, which could reflect the previous shift work of the participant. This implies that there is an average time lag of 1 year between QR and insomnia. Further studies should be implemented to elucidate causal relationships. In addition, QR is a question asking about experiences in the past 6 months, and the frequency of this has not been measured. Although the association between the increase in the frequency of QR and the occurrence of insomnia caused by QR could be increased, this could not be confirmed due to the lack of information in the questionnaire. Second, information on previous diseases or lifestyle habits that could affect insomnia was lacking, especially information on mental disorders or history of alcohol use, which might be a source of confounding bias. Although the unmeasured bias could have been mitigated by the large sample size, future studies should be designed to overcome this limitation. Third, information about the night-shift work profile was obtained by questionnaires, which could have introduced recall/reporting bias. Trained nurses double-checked the self-reports to minimize bias by determining the presence of any awkward responses.

## 5 | CONCLUSION

In conclusion, our study established a substantial correlation between QR and insomnia utilizing the CDM approach and data from multiple centers. Thus, the findings of this study may serve as a foundation for developing guidelines to enhance the health of shift workers and prevent occupational accidents.

### AUTHOR CONTRIBUTIONS

J Sim and B Yun wrote the manuscript and were responsible for the conception of the study and data analysis. J Oh and A Cho collected data from each institution. JH Lee and S-K Kim conceived the ideas. JH Yoon contributed with insight, scientific discussion, and editing of the manuscript. All authors contributed to the article and approved the submitted version.

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## CONFLICTS OF INTEREST

**Approval of the research protocol:** The Institutional Review Board of Severance Hospital authorized the study protocol, which adhered to the ethical standards of the Declaration of Helsinki of 1975 (IRB identification number: Y-2020-0011). **Informed Consent:** The need for obtaining informed consent from the participants was waived, owing to the retrospective nature of this study. **Registry and the Registration No. of the study/trial:** N/A. **Animal Studies:** N/A. **Conflict of Interest:** N/A.

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## SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher's website.

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