Sleep Patterns of Firefighters with Shift Working Schedules in Seoul Metropolitan Area

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Background and Objective Firefighters suffer from irregular and inadequate sleep, often due to their shift work schedule. The purpose of this study was to investigate the shift work schedules and their effects on the quality of sleep in Korean firefighters.

Methods This study included firefighters in the Seoul Metropolitan area, who participated in the "Firefighters' Healing Camp" and answered questionnaires for their shift work schedules and sleep-related symptoms. Among 180 participating firefighters, 110 subjects completed detailed sleep questionnaires, which included the Pittsburgh Sleep Quality Index, the Insomnia Severity Index, the Epworth Sleepiness Score, the Stanford Sleepiness Score, the Fatigue Severity Scale, and the Berlin Questionnaire, and provided details of their shift work schedule and duration for the last 3 weeks.

Results Among 110 respondents, 78.2% self-reported sleep disturbance and approximately 60% of the participating firefighters had a certain degree of insomnia. Furthermore, more than 50% of the firefighters complained of excessive daytime sleepiness, with 31.8% having a risk of obstructive sleep apnea (OSA). The firefighters in the frequent night-shift (NS) working pattern (5 or more days for 3 weeks), showed significantly higher Pittsburgh Sleep Quality Index global score than those in the infrequent (less than 5 days) NS group (8.8 ± 3.6 vs. 6.7 ± 2.7 , $p = 0.014$). However, the frequent NS working pattern was not associated with excessive daytime sleepiness or OSA risk.

Conclusions The participating firefighters reported a high prevalence of various sleep problems. Frequent NS working may be responsible for poor sleep quality in firefighters.

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INTRODUCTION

Firefighters are exposed to strenuous and dangerous working conditions. They must maintain full readiness for 24 hours against fire accidents and other incidents that require rescue operations. These working conditions put them at risk of various health problems.¹⁻³ Sleep disorders are also very common in the firefighters due to multiple factors.^{4,5} Considering the work-related dangers firefighters are constantly exposed to, it is highly likely that sleep disorders in this occupation may lead to serious work-related accidents.⁶

Recently, a number of studies have reported the prevalence of sleep disorders among firefighters ranging between 48 to 70% in many countries including United States, Brazil, Iran, and Korea.^{1,5,7,8} This is likely caused by disruption of the circadian rhythm due to emergency dispatches, nighttime shifts, and other factors that prevent firefighters from sleeping at night. In particular, firefighters are exposed to light during night-shift (NS), that stimulates the produc-

tion of melatonin, preventing those individuals from having deep sleep.⁹ However, few studies have been performed on the working conditions of the firefighters related to the circadian disruption, indicating the need to research on what adequate working conditions are to ensure the firefighters' health and safety, regarding the issue of sleep problems.

This is a descriptive and quantitative report, based on the results of a survey circulated among the firefighters, who participated in a government-supported healing camp. The current study utilized various questionnaires related to the quality of sleep to investigate overall sleep health and daytime sleepiness in Korean firefighters. Moreover, the researchers collected detailed and quantitative information regarding their working patterns and attempted to study potential influences of the NS working schedule on the sleep quality.

This study was performed to investigate the shift work schedules and their effects on the quality of sleep in Korean firefighters. We hypothesized that the NS working schedule would have a significant impact on their sleep disturbances. Our findings showed that sleep-related problems are highly prevalent in Korean firefighters, partly related to poor sleep quality due to frequent NS working schedules.

METHODS

Subjects

The study subjects were 180 firefighters in the Seoul Metropolitan area, who participated in the "Firefighters' Healing Camp" which took place in 2016. A survey was given out to 180 participants, among whom 118 responded. 8 were excluded due to missing data, ultimately leaving data from 110 participants. The survey asked for detailed working schedules including the duration of each working type for the recent three weeks. When counting the total hours of work time, day-shift was counted as 9 hours, NS was counted as 16 hours, and all-day on duty was counted as 24 hours. In addition, the following sleep-related questionnaires were distributed and collected.

Completion of the questionnaire was voluntarily performed by all participants as part of the camp program and was conducted entirely anonymously. This study was approved by the Institutional Review Board, and the informed consent was waived due to the nature of the simple questionnaire survey in this study (IRB No. 2015-12-13-016).

Sleep-Related Questionnaires

Pittsburgh Sleep Quality Index

The Pittsburgh Sleep Quality Index (PSQI) is a self-report questionnaire that assesses sleep quality over a 1-month time interval.¹⁰ The PSQI consists of 19 items, that subjectively measure seven components including subjective sleep quality, sleep la-

tency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime function to evaluate different aspects of sleep. Each sleep component is scored on a 0 to 3 scale, with 3 denoting the worst quality, adding together into a global score ranged from 0 to 21, where higher scores denote poor sleep quality. The cut-off value of 6 or higher for the PSQI global score is defined as poor sleepers.¹⁰

Insomnia Severity Index

The Insomnia Severity Index (ISI) consists of seven items asking self-assessment of the severity of insomnia symptoms.^{11,12} Each item is scored on a 0 to 4 scale, with 4 denoting the highest severity. The total scores range from 0 to 28 with lower scores, representing mild or absence of insomnia symptoms and higher scores suggesting more severe insomnia.

Epworth Sleepiness Scale

The Epworth Sleepiness Scale (ESS) asks a respondent to score the likelihood of dozing on a 0 to 3 scale, with 3 being most likely in eight real life situations.¹³ The degree of daytime sleepiness is evaluated, based on the overall total score equaling the sum of responses to the eight items (ranging from 0 to 24). A respondent with ESS total score higher than 10 is regarded as having clinically significant excessive daytime sleepiness.

Stanford Sleepiness Scale

The Stanford Sleepiness Scale (SSS) is an assessment of alertness and levels of sleepiness throughout the day.¹⁴ Rating alertness is unidimensional, based on a 1 to 7 scale, with 1 being a state of alert and feeling active and 7 being a state of dreamy or likely to fall asleep soon.

Fatigue Severity Scale

The Fatigue Severity Scale (FSS) is one of the most frequently used self-assessment questionnaires for measuring the impact of fatigue usually for subjects with chronic illness.¹⁵ The FSS contains 9 statements that rate the severity of one's fatigue symptoms. Each statement is scored on a 7-point Likert type scale, ranging from 1 (strongly disagree) to 7 (strongly agree), and a total FSS score > 36 is considered to have severe fatigue or need for further evaluation.

Berlin Questionnaire

The Berlin Questionnaire (BQ) is a brief and validated screening tool, that is intended to identify persons in the community who are at high risk for obstructive sleep apnea (OSA).¹⁶ The BQ contains questions related to snoring (category 1), daytime functioning (category 2), and hypertension or body mass index (BMI) > 30 (category 3). Scores from the first and second categories are determined positive, if the responses are "yes" or loud snoring (louder than talking or can be heard in adjacent rooms) or frequent equally to or more frequent than 3-4 time a week.

Table 1. Demographic and shift work patterns between respondents with NS less than 5 days (NS < 5 days) and more than 5 days (NS ≥ 5 days) during recent 3 weeks

	Total (n = 110)	NS < 5 days (n = 21)	NS ≥ 5 days (n = 89)	p value
Demographics				
Age (years)	42.5 ± 9.0	40.6 ± 8.0	42.9 ± 9.2	0.258
Gender (male:female)	109:1	21:0	80:1	NA
BMI	24.4 ± 2.3	24.9 ± 2.1	24.3 ± 2.4	0.260
Hypertension (%)	19 (17.3)	3 (14.3)	16 (18.0)	0.687
Diabetes (%)	1 (0.9)	0 (0.0)	1 (1.1)	NA
Hyperlipidemia (%)	2 (1.8)	1 (4.8)	1 (1.1)	0.262
Smoking (%)	38 (34.5)	5 (23.8)	33 (37.1)	0.250
Drinking (%)	89 (80.9)	17 (81.0)	72 (80.9)	0.996
Caffeine intake (%)	99 (90.0)	20 (95.2)	79 (88.8)	0.374
Work duration				
Day-shift (days)	6.0 ± 3.0	10.6 ± 4.6	5.0 ± 0.6	< 0.001*
NS (days)	4.4 ± 1.8	1.2 ± 1.7	5.1 ± 0.4	< 0.001*
All-day on duty (days)	2.0 ± 1.1	2.2 ± 2.4	2.0 ± 0.5	0.708
Total work (hours)	173.1 ± 16.7	168.4 ± 30.9	174.2 ± 10.6	0.406
Duration of the NS (%)				
None	13 (11.8)	13 (61.9)	0 (0.0)	NA
1–4 days	8 (7.3)	8 (38.1)	0 (0.0)	NA
5 ≤ days	89 (80.9)	0 (0.0)	89 (100.0)	NA
Off-duty (%)				
None	0 (0.0)	0 (0.0)	0 (0.0)	NA
1–4 days	0 (0.0)	0 (0.0)	0 (0.0)	NA
5–9 days	109 (99.1)	21 (100.0)	88 (98.9)	NA
10 ≤ days	1 (0.9)	0 (0.0)	1 (1.1)	NA

*Statically significant by ANOVA.

NS: night-shift, BMI: body mass index, NA: not applicable.

The category 3 is positive, when a subject has a history of hypertension. A subject with 2 or more categories positive is determined to have OSA risk.

Statistical Analysis

A t-test was used to compare numerical mean values between the infrequent and frequent NS working groups. A chi-square test was used to evaluate the effects of NS frequency, on the proportion of the subjects belonging to different ranges of various sleep-related scales.

RESULTS

Demographic Characteristics and Pattern of Work Schedule

Demographic data from 110 respondents is presented in Table 1. The majority of firefighters are comprised of males (109 males and 1 female), and the mean age was 42.5 ± 9.0 years old,

ranging from 25 to 59 years. The BMI of the respondents was 24.4 ± 2.3 on average. Among them, 17.3% (19/110) had hypertension in their medical history (Table 1). Approximately one third (34.5%, 38/110) of the respondents were current smokers.

The firefighters were asked for detailed working schedules and durations of their schedules for the last 3 weeks. Their working schedules consist of day-shift working for 9 hours during daytime, the NS working for 16 hours during evening and night, and all-day on duty at the office for 24 hours, without being deployed to a field of emergency. The average days of the NS were 4.4 ± 1.8, ranging from 0 to 7 days, during a period of recent 3 weeks. The average day-shift days were 6.0 ± 3.0 days. The most frequent working pattern comprised 5 days of the day-shift and 5 days of the NS during a period of three weeks, which pertained to 71% (78/110) of all the respondents. In this group, days of the all-day on duty ranged from 1 to 3 days (mostly 2 days), constituting a smaller fraction of their workloads.

Since most of the firefighters had 5 days of the NS, all the respondents were divided into an infrequent NS group with less

Table 2. General sleep characteristics based on the PSQI between respondents with NS less than 5 days (NS < 5 days) and more than 5 days (NS ≥ 5 days) during the recent 3 weeks

	Total (n = 110)	NS < 5 days (n = 21)	NS ≥ 5 days (n = 89)	p value
Sleep habits (min)				
Time to bed	23:58 ± 72	00:06 ± 62	23:55 ± 74	0.838
Duration till falling asleep	31.1 ± 34.5	29.7 ± 18.6	31.4 ± 36.2	0.381
Time to get-up	06:54 ± 91	06:45 ± 61	06:56 ± 97	0.885
Duration of sleep	382 ± 102	373 ± 76	384 ± 107	0.700
Questions related to sleep problems (0–3)				
Can't sleep within 30 min	1.43 ± 0.98	1.09 ± 0.87	1.49 ± 0.99	0.074
Wakeup at night/early morning	1.56 ± 0.97	1.43 ± 0.04	1.60 ± 0.97	0.103
Wakeup for bathroom	1.37 ± 0.94	0.90 ± 0.81	1.48 ± 0.94	0.007†
Can't breathe during sleep	0.43 ± 0.78	0.48 ± 0.79	0.42 ± 0.78	0.756
Cough or snore during sleep	0.84 ± 0.92	1.05 ± 0.95	0.79 ± 0.91	0.265
Too cold during sleep	0.55 ± 0.75	0.48 ± 0.73	0.56 ± 0.75	0.656
Too hot during sleep	0.57 ± 0.78	0.33 ± 0.56	0.63 ± 0.81	0.051
Bad dreams during sleep	0.72 ± 0.80	0.76 ± 0.92	0.71 ± 0.77	0.819
Body ache during sleep	0.38 ± 0.67	0.14 ± 0.47	0.44 ± 0.70	0.022‡
Can't sleep due to other reasons	0.86 ± 1.16	0.86 ± 1.08	0.87 ± 1.18	0.970
Other sleep-related questions (0–3)				
Taking sleep pills	0.05 ± 0.25	0.00 ± 0.00	0.06 ± 0.27	0.038‡
Difficult to stay awake	0.67 ± 0.81	0.48 ± 0.73	0.72 ± 0.82	0.195
Difficult to concentrate	0.92 ± 0.88	0.62 ± 0.72	0.99 ± 0.89	0.051
Self-report sleep quality	1.39 ± 0.91	1.14 ± 0.77	1.44 ± 0.93	0.133
PSQI global score (mean value)	11.7 ± 6.6	9.4 ± 4.2	12.3 ± 6.9	0.016‡
PSQI 0–4 (%)	34 (30.9)	9 (42.9)	25 (28.1)	0.188
PSQI 5 ≤* (%)	76 (69.1)	12 (54.5)	64 (71.9)	

*Defined as having a risk of sleep problem. †Statically significant by ANOVA. ‡Statistically significant at p<0.05 by ANOVA.

PSQI: Pittsburgh Sleep Quality Index, NS: night-shift.

Table 3. ISI between respondents with NS less than 5 days (NS < 5 days) and more than 5 days (NS ≥ 5 days) during the recent 3 weeks

	Total (n = 110)	NS < 5 days (n = 21)	NS ≥ 5 days (n = 89)	p value
Questions related to insomnia (0–4)				
Difficult to fall asleep	1.07 ± 1.01	1.00 ± 1.03	1.09 ± 1.03	0.721
Difficult to maintain	1.08 ± 1.04	0.95 ± 1.05	1.11 ± 1.05	0.535
Easy to wake at night	1.45 ± 1.13	1.24 ± 1.13	1.49 ± 1.13	0.369
Sleep satisfaction	1.97 ± 1.19	1.67 ± 1.17	2.04 ± 1.17	0.202
Disturb daily activity	1.41 ± 0.98	1.43 ± 0.97	1.40 ± 0.97	0.899
Disturb quality of life	1.16 ± 1.04	1.05 ± 1.06	1.19 ± 1.06	0.590
Concern for insomnia	0.99 ± 1.12	0.71 ± 1.16	1.06 ± 1.16	0.223
ISI (mean value)	9.14 ± 6.34	8.95 ± 7.29	9.18 ± 6.16	0.895
0–7 (no risk, %)	46 (41.8)	10 (47.6)	36 (40.4)	0.936
8–14 (mild risk, %)	41 (37.3)	7 (33.3)	34 (38.2)	
15–21 (moderate risk, %)	16 (14.5)	3 (14.3)	13 (14.6)	
21 < (severe risk, %)	7 (6.4)	1 (4.8)	6 (6.7)	

ISI: Insomnia Severity Index, NS: night-shift.

than 5 days of NS and frequent NS group with 5 days or more of NS working pattern. The sleep questionnaire data was compared between the two groups in the subsequent analyses. As shown in Table 1, the demographic characteristics and the frequency of underlying co-morbidity were not significantly different between the two groups. Life styles related to smoking, drinking, and caffeine consumption were also similar between the two groups.

Overall Quality of Night Sleep and Sleep-Related Behaviors

General characteristics of night sleep and sleep-related behaviors were analyzed, based on the responses to the PSQI. Quantitative comparisons of night sleep habits did not show a significant difference between infrequent and frequent NS groups

(Table 2). Among all the respondents, 78.2% (86/110) had a PSQI global score equal to or higher than 6, which is defined as having a risk of sleep problems.¹⁰ The firefighters with frequent NS working pattern revealed significantly higher PSQI global score values than those with infrequent NS (8.8 ± 3.6 vs. 6.7 ± 2.7 , $p = 0.014$) (Table 2), indicating that firefighters with frequent NS are more likely to suffer from poor sleep quality. Subcategorical analysis of the questionnaires showed a tendency that firefighters with frequent NS have more frequent sleep problems. Two sub-categories showed statistically significant differences: frequency of wakeup for bathroom during the night ($p = 0.007$) and of bodily aches during sleep ($p = 0.022$). More importantly, 4 firefighters from the frequent NS group, but none from the infrequent NS group, had a history of taking sleep pills, with one person having the medicine regularly a couple of times a week (p

Table 4. Excessive daytime sleepiness based on the ESS and the SSS between respondents with NS less than 5 days (NS < 5 days) and more than 5 days (NS $\geq$ 5 days) during the recent 3 weeks

	Total (n = 110)	NS < 5 days (n = 21)	NS ≥ 5 days (n = 89)	p value
Severity of sleepiness in each situation (0-3)				
Reading	1.45 ± 0.90	1.76 ± 0.81	1.37 ± 0.90	0.061
Watching TV	1.06 ± 0.74	1.10 ± 0.81	1.06 ± 0.72	0.837
In public	0.87 ± 0.79	0.86 ± 0.94	0.88 ± 0.75	0.928
Public transport >1 hr	1.36 ± 0.96	1.33 ± 0.99	1.37 ± 0.95	0.868
Lying in the afternoon	1.72 ± 0.90	1.71 ± 0.88	1.72 ± 0.90	0.963
Talking to others	0.27 ± 0.52	0.14 ± 0.35	0.30 ± 0.55	0.103
After lunch	1.44 ± 0.92	1.52 ± 1.14	1.42 ± 0.86	0.709
Wait for traffic light	0.72 ± 1.25	0.57 ± 0.79	0.75 ± 1.33	0.423
ESS total scores (mean value)	8.89 ± 4.56	8.82 ± 4.55	9.20 ± 4.73	0.735
0-10 (%)	47 (42.7)	11 (52.4)	53 (59.5)	0.549
10 <* (%)	63 (57.3)	10 (47.6)	36 (40.5)	
SSS (1-7) (mean value)	2.76 ± 0.90	2.57 ± 0.79	2.80 ± 0.91	0.252
1-3 (%)	98 (89.1)	20 (95.2)	78 (87.6)	0.572
4-7 (%)	12 (10.9)	1 (4.8)	11 (12.3)	
Questions related to FSS (1-7)				
No desire	4.48 ± 1.77	4.62 ± 1.99	4.45 ± 1.72	0.721
Fatigue after exercise	3.60 ± 1.56	3.62 ± 1.73	3.60 ± 1.51	0.961
Frequent fatigue	3.88 ± 1.70	3.62 ± 1.62	3.94 ± 1.72	0.427
Reduced physical activity	3.81 ± 1.67	3.57 ± 1.62	3.87 ± 1.67	0.454
Often cause problems	3.07 ± 1.61	2.90 ± 1.19	3.11 ± 1.69	0.509
Difficult sustained physical activity	3.26 ± 2.47	2.90 ± 1.31	3.34 ± 2.66	0.277
Can't do work load or duty	2.70 ± 1.60	2.43 ± 1.43	2.76 ± 1.63	0.362
One of the most difficult 3 things	3.44 ± 2.03	3.05 ± 2.03	3.53 ± 2.02	0.337
Work, family, social life problems	2.96 ± 1.76	2.90 ± 1.72	2.98 ± 1.77	0.850
FSS total scores (mean value)	31.20 ± 12.68	30.94 ± 12.73	32.35 ± 12.73	0.651
0-36 (%)	48 (43.6)	11 (52.4)	51 (57.3)	0.167
36 < (%)	62 (56.4)	10 (47.6)	38 (42.7)	

*Defined as having excessive daytime sleepiness.

ESS: Epworth Sleepiness Scale, SSS: Stanford Sleepiness Scale, NS: night-shift, FSS: Fatigue Severity Scale.

= 0.038).

Consistent with the high percentage of participating firefighters with a risk of sleep problems, 58.2% (64/110) of the respondents had certain degree of insomnia risk (Table 3). A total of 7 firefighters (6.4%) showed an ISI score higher than 21, which is considered a severe risk of insomnia. Among them, 6 subjects belonged to the frequent NS group. However, the average ISI total score was not significantly different between the two groups. In the sub-categorical analysis, the firefighters with a frequent NS working pattern tended to have worse sleep quality and to show signs of the possibility of having insomnia.

Daytime Sleepiness, Fatigue, and the Risk of OSA

Sleepiness during daytime and/or fatigue can be caused because of poor night sleep quality and may lead to work-related accidents, which would be dangerous for the firefighters. Excessive daytime sleepiness was analyzed based on the ESS and SSS. More than 50% (57.4%, 63/110) of the participating firefighters showed an ESS total score higher than 10, which is defined as having excessive daytime sleepiness (Table 4). As for the SSS, almost 90% (89.1%, 98/110) subjects reported a score equal to or lower than 3. The mean score of the ESS or SSS was not significantly different between the firefighters with infrequent and frequent NS working patterns. Only one subject in the infrequent NS working group reported a SSS score higher than 3, but 11 subjects in the frequent NS working group (12.3%) reported a SSS score higher than 3. Two firefighters out of the 11 subjects reported a SSS score 6, which corresponded to a state where a subject was sleepy, woozy, and fighting sleep, and preferred to lie down. However, the chi-square analysis did not reveal statistical significance in the proportion of the firefighters in the frequent NS working group reporting SSS score higher than 3. Severity of subjective fatigue was asked, using the

FSS ranging from 1 to 7. The average total score of the FSS was similar between the two groups, and the percentage of the subjects with a Fatigue Scale higher than 36 was also comparable (Table 4).

The risk of having OSA was assessed using the BQ. Answers to individual BQ sub-categories were similar between the two groups (Table 5). In addition, the total BQ scores, combining all the sub-categories, were not significantly different between the infrequent and frequent NS working groups. The overall percentage of firefighters having risk of OSA was 31.8% (35/110). The firefighters with frequent NS working patterns had slightly higher risk than those with infrequent NS, but the difference was not statistically significant.

DISCUSSION

The current study revealed that sleep-related problems are highly prevalent in Korean firefighters. Approximately 80% subjects were deemed to have sleep problems based on a PSQI global score. In addition, analysis of the ISI showed that 58.2% were likely to have insomnia. A previous population-based epidemiologic study reported that 22.8% of Korean adults have insomnia.¹⁷ Epidemiologic data in western countries showed a similar prevalence of sleep-related problems in a general adult population.^{18,19} Therefore, the prevalence of sleep problems seems to be at least 3-fold higher in the Korean firefighters than that in normal adults. The finding of our study is consistent with a previous study, reporting that 48.7% of the Korean male firefighters have sleep disorders. The prevalence of sleep problems and/or insomnia in the firefighters of other countries is also comparable to that of this study.^{1,7,20} The researchers also found that more than 50% of the participating firefighters suffer from

Table 5. Risk of obstructive sleep apnea based on the BQ between respondents with NS less than 5 days (NS < 5 days) and more than 5 days (NS ≥ 5 days) during the recent 3 weeks

	Total (n = 110)	NS < 5 days (n = 21)	NS ≥ 5 days (n = 89)	p value
Symptoms related to snoring (a)	2.10 ± 2.06	2.05 ± 1.70	2.11 ± 2.14	0.898
Daytime functioning (b)	1.34 ± 1.14	1.71 ± 1.24	1.25 ± 1.09	0.092
Comorbidity (hypertension) (c) (%)				
Yes	19 (17.3)	3 (14.3)	16 (18.0)	0.687
No	91 (82.7)	18 (85.7)	73 (82.0)	
Total BQ score (a+b+c)	3.61 ± 2.47	3.90 ± 2.09	3.54 ± 2.55	0.547
BQ Index (%)				
0-5	74 (83.6)	14 (66.7)	60 (67.4)	0.948
6-10	36 (16.4)	7 (33.3)	29 (32.6)	
Risk of OSA (%)*				
Yes	35 (31.8)	6 (28.6)	29 (32.6)	0.722
No	75 (68.2)	15 (71.4)	60 (67.4)	

*Risk of OSA is determined if the number of positive categories > 2 among three categories of BQ (a, b, c).

BQ: Berlin Questionnaire, NS: night-shift, OSA: obstructive sleep apnea.

excess daytime sleepiness. The percentage of the subjects having a risk of OSA was 31.8%, which is like the 28.4% of United States firefighters having OSA reported in a previous study.⁶ Considering the 4% of OSA prevalence in middle-aged males,²¹ OSA risk in the participating firefighters, in this study seems to be exceptionally high.

The frequent NS working pattern (5 days or more in 3 weeks) was significantly associated with poor sleep quality, based on PSQI in Korean firefighters. It has been established that NS can cause various sleep-related problems in other occupations.^{22,23} Frequent NS may interrupt circadian rhythm, rendering intrinsic biological clock unstable.^{24,25} Difficulties in maintaining appropriate circadian rhythm not only affects the sleep quality but also leads to altered homeostasis in other organ systems.^{26–28} The systemic effects may in turn, negatively influence the quality of sleep during the night. In the current study, the firefighters in the frequent NS working pattern complained of wakeup incidents for bathroom and body aches, during sleep more seriously than those who belonged to the infrequent NS group. It is plausible that these complaints may be early signs of systemic illness in the cardiovascular or musculoskeletal systems. Four 4 out of all the participating firefighters reported behavioral experiences of seeking sleep pills and all those 4 subjects belonged to the frequent NS working group. This finding suggests that chances of encountering undiagnosed patients with sleep disorders that require medical attention are much higher among firefighters with frequent NS working pattern.

Contrary to the significant association of the frequent NS working pattern with poor sleep quality, there was no significant difference in daytime sleepiness or a risk of OSA between the infrequent and frequent NS groups. OSA is one of the most common sleep disorders that is responsible for excessive daytime sleepiness. Although life style or environmental factors can increase the risk of OSA in adults, hereditary or constitutional factors like family history and airway structures also significantly contribute to development of OSA.²⁹ Therefore, shift-working schedules may have less to do with OSA development and the lack of difference in OSA risk may result in a similar level of daytime sleepiness between the two groups. It is conceivable that the high prevalence of OSA risk in the subjects of this study may be linked to potential pulmonary function problems in firefighters.³⁰ Excessive daytime sleepiness may be presented as a form of hypersomnolence which in turn, is one of the cardinal symptoms in depressive disorders.³¹ Depression among firefighters is strongly associated with difficulties in emotion regulation that are commonly encountered in post-traumatic stress disorder.²⁰ Therefore, depressive mood state, probably due to occupational peculiarity of firefighters, may influence daytime sleepiness more strongly than shift-working patterns. During this study, the researchers identified several firefighters that met the diagnostic criteria of various sleep disorders, including those who took sleep pills. In fact, a previous study reported

that 37.2% of firefighters screened positive for any sleep disorder and these subjects, having sleep disorders, were more likely to report a motor vehicle crash or had adverse health outcomes.⁶ These findings strongly argue for the necessity of mandatory screening for sleep problems in the firefighters that are exposed to dangerous incidents, requiring the highest level of alertness and concentration. In fact, a recent study implemented a sleep health program, consisting of questionnaire-based sleep disorder screening and sleep health education, and reported the effectiveness of the programs in reduction of work-related injuries or work loss due to disabilities.³² This study provides evidence that sleep health screening or an appropriate intervention should be prioritized for the firefighters with frequent NS working patterns.

This study is valuable because the firefighters voluntarily participated in the survey, not compulsorily as a periodical health check-up. Although one cannot draw a definitive conclusion from one survey with small sample size, the firefighters who participated in this survey show signs of various sleep problems. Of course, it is difficult to generalize the findings in this study as being representative of the entire group. However, chronic sleep disturbances of Korean firefighters need to be considered due to the possible long-term complications that they may bring. Based on the findings made from this study, several suggestions can be made to improve the quality of sleep in Korean firefighters. First, it is necessary to investigate the sleep quality associated with more detailed nocturnal work schedules for the entire firefighters with frequent dispatches to emergency at night. Second, a standard guideline of recommendations can be made on changes in the pattern of night work shift in a way to reduce the frequency of NS. Third, advice and care for sleep problems as well as other health problems for the individual firefighters should be provided in an easily accessible way. These efforts would reduce the risk of chronic health problems related to long-term sleep disturbances even after serving as a firefighter for a long time (i.e. 20–30 years).

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Conflicts of Interest

The authors have no financial conflicts of interest.

Authors' Contribution

Conceptualization: Kim HW, Kim EJ, Kim HJ. Data curation: Kim HW, Jung SM, Choi YS, Kim SA, Joung HY. Formal analysis: Kim HW, Jung SM. Funding acquisition: none. Methodology: Kim HW, Jung SM, Choi YS, Kim SA, Joung HY. Project administration: Jung SM. Resources: Jung SM. Software: Jung SM, Kim HJ. Supervision: Kim EJ, Kim HJ. Validation: Kim HW, Jung SM, Choi YS, Kim SA, Joung HY, Kim HJ. Visualization: Kim HW, Jung SM, Choi YS, Kim SA, Joung HY, Kim HJ. Writing—original draft: Kim HW, Jung SM, Kim HJ. Writing—review & editing: Kim HW, Kim EJ, Kim HJ.

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