ORIGINAL ARTICLE

J Korean Acad Community Health Nurs (지역사회간호학회지)

ISSN 1225-9594 (Print) / ISSN 2288-4203 (Online)
Vol. 33 No. 4, 396-407, December 2022
https://doi.org/10.12799/jkachn.2022.33.4.396

Influencing Factors for Sleep Quality among Firefighters: Based on Objective and Subjective Evaluation

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Purpose: The purpose of this study was to assess insomnia and the quality of sleep, investigate the concordance between objective and self-report sleep patterns, and identify physiological, psychological, and situational factors influencing insomnia and sleep quality among firefighters. **Methods:** A descriptive, cross-sectional study was conducted with 103 firefighters in Korea. The collected data were analyzed using SPSS 23.0. Descriptive statistics, the independent t-test, and hierarchical logistic regression analysis were performed. **Results:** Insomnia was found in 66 (64.1 %) of the total subjects, and the average quality of sleep (PSQI) was 5.65 (SD=2.57). Total sleep time (401.00 minutes) and sleep latency (21.60 minutes) measured using self-reported scales were longer than the ones measured using objective measurements by approximately 48.70 and 17.10 minutes, respectively. Factors related to insomnia included the role as a paramedic (OR=4.28, 95% CI: 1.02~17.92), anxiety (OR=1.12, 95% CI: 1.01~1.24), and sedentary lifestyle (OR=0.85, 95% CI: 0.78~0.94), and factors related to sleep quality were physical illness status (OR=5.17, 95% CI: 1.53~17.51) and social support (OR=0.86, 95% CI: 0.78~0.95). **Conclusion:** The results show a high prevalence of insomnia, poor quality of sleep and the discrepancy between objective and subjective sleep patterns among firefighters. To promote sleep quality and health, early screening and treatment of anxiety and physical illness are required. It is necessary to conduct further studies examining the relationship between physical activity level and sleep.

Key Words: Actigraphy; Firefighters; Occupational Health; Sleep

INTRODUCTION

1. Background

When disasters such as a fire and an earthquake occur, firefighters are required to move quickly to the incident sites to respond to emergency situations and protect the lives of the public. Under these circumstances, firefighters inevitably have to work in a state of high physiological and psychological tension, so they have been reported to show higher levels of depression and anxiety as well as a higher prevalence of post-traumatic stress disorder (PTSD) than other occupational groups [1,2]. These problems are also shown by the findings of a prior study reporting that 28.1% of firefighters were found to be diagnosed with mental problems, and the most common symptom was alcohol use disorder, followed by sleep disorder, depression, and PTSD [3]. Firefighters' mental problems such as depression and PTSD are positively correlated with sleep disorder and suicidality, and sleep problems may lead to a decrease in job performance and a deterioration in quality of life, so there is an urgent need for active interventions for these problems [4,5].

In Korea, 83.2~100% of firefighters are reported to work in shifts, and 48.7~86.8% of firefighters were found to experience poor sleep quality [5-7]. When sleep patterns are measured with an actigraphy used for objective sleep measurement, a sleep efficiency of less than 85% and the

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- This research was supported by the BK21 four project (Center for Human-Caring Nurse Leaders for the Future) funded by the Ministry of Education (MOE, Korea) and National Research Foundation of Korea (NRF).
- This article is a condensed form of the first author's master's thesis from Seoul National University.

Received: Apr 22, 2022 / Revised: Sep 1, 2022 / Accepted: Oct 31, 2022

total sleep time of less than 360 minutes are considered to indicate sleep problems [8]. According to a previous study, in firefighters working on day shifts, the average total sleep time per day was 347.7 minutes and 72.8% of the subjects showed a sleep efficiency of less than 85% [9]. It was also reported that, in firefighters working on night shifts, the average total sleep time was 266.9 minutes, and 92.9% of the subjects showed poor sleep efficiency, showing that firefighters in Korea have serious sleep problems in terms of both the quantity and quality of sleep [9]. Mental health problems and sleep disorders are likely to lead to a decrease in job satisfaction and the deterioration of physical health [2], which means a shortage of firefighting personnel and the increase of the number of people that a firefighter is responsible for [6]. Thus, the mental health problems and sleep disorders of firefighters can become a factor threatening the health of the entire community.

According to previous studies, the sleep of firefighters is associated with physical illness, depression, anxiety, occupational stress, physical activity level, and drinking status [2,5,7,10,11]. Further, the prevalence of depression among firefighters was reported to be 43.2%, and 43.7% of firefighters were found to experience a high level of occupational stress [10], and these problems were shown to be related to sleep deprivation and poor sleep quality [5,12]. In addition, anxiety, drinking, caffeine, and physical activity level were found to be factors affecting the sleep of firefighters [2,7,11,12]. In this study, to comprehensively explore physiological, psychological, and situational factors affecting the sleep of firefighters, the theoretical framework of this study was posited based on the Theory of Unpleasant Symptoms proposed by Lenz et al. [13]. According to this theory, symptoms, which are a multidimensional concept, are influenced in complex ways by physiological, psychological, and situational factors, and symptoms can be efficiently managed by identifying influencing factors for them [13]. This study examined the physical illness status as a physiological factor, depression, anxiety, and occupational stress among psychological factors, and physical activity level, drinking, smoking, and perceived social support among situational factors.

In all the previous studies on sleep among firefighters conducted in Korea [5-7,12], sleep was measured only by using self-report logs or subjective survey tools, so the results of the studies may have been influenced by response bias. Actually, it has been reported that although the discrepancy between self-reported and objectively measured sleep states is commonly observed even in the normal group, greater discrepancies are observed in the insomnia group [14,15]. Therefore, there is a need to investigate the sleep of firefighters in a multifaceted and comprehensive manner by using both subjective and objective measurement tools.

Although there are various methods for examining sleep, including polysomnography, electroencephalography, the multiple sleep latency test, and impulse radio ultra-wideband (IR-UWB) [11,16], actigraphy was used in the present study because this device has several advantages. In particular, the use of actigraphy allows subjects to perform their daily activities and sleep as usual, and allows the collection of data for several consecutive days, which enables the identification of sleep cycles [17]. In several studies that compared polysomnography and actigraphy, which are the most commonly used standard methods, the high levels of accuracy and validity of actigraphy have been verified [16].

In a study on sleep using actigraphy among firefighters in Korea [9], sleep patterns were investigated according to different work patterns (daytime work, shift work, off duty) and the types of shift schedule (3-, 6-, 9-, and 21-day cycles). However, the psychological states closely related to sleep were not measured. The examination of foreign studies on the sleep of firefighters using actigraphy conducted so far [11,17-19] revealed that it is difficult to apply the results of foreign studies to Korean firefighters due to differences in the causes of fire incidents, the status of fire suppression, and working environments. More specifically, in Australia and Canada, firefighters' works are mostly related to the sites of suppression operations to extinguish naturally occurring fires. On the other hand, the majority of the types of emergencies that Korea's firefighters respond to include property damage, marine accidents, road traffic accidents, and fires rather than natural disasters [17-20]. In addition, it has been found that Korean firefighters' work schedule includes fewer days off duty, and that the number of people that one firefighter is responsible for is higher in Korea than in other countries. Therefore, in view of these findings, it is necessary to conduct research taking into account Korea's situations [6].

Therefore, this study aimed to examine the presence of insomnia, sleep quality, and objective and subjective sleep patterns and compare objectively measured and self-reported sleep patterns, and identify factors affecting insomnia and sleep quality among Korean firefighters.

2. Purpose

The specific objectives of this study are as follows: 1) To investigate the presence of insomnia and sleep quality among firefighters; 2) to compare objective sleep patterns

measured by an actigraphy, an objective measurement tool, with subjective sleep patterns measured by the Pittsburgh Sleep Quality Index (PSQI); 3) to examine physiological, psychological and situational factors affecting insomnia and sleep quality among firefighters.

METHODS

1. Study Design

This study is a cross-sectional descriptive study to examine the presence of insomnia and sleep quality and identify factors influencing insomnia and sleep quality among firefighters.

2. Participants

The participants of this study were firefighters who were working on day shifts according to the three-shift work schedule with a 21-day cycle, and they were selected by convenience sampling among the firefighters performing tasks such as fire suppression, paramedic, and rescue activity. Only the firefighters who understood the purpose of this study and voluntarily signed an informed consent form were included in this study. With respect to the work pattern of the three-shift schedule with a 21-day cycle, the work schedule of the first week consists of five daytime shifts followed by two days off as follows: day shift - day shift - day shift - day shift - day shift - off-duty - off-duty. The work schedule of the second week includes night shifts as follows: night shift - off duty -night shift - off duty - night shift - off duty - watch duty. The work schedule of the third week is as follows: off duty - night shift - off duty - night shift - off duty - watch duty - off duty. This three-week cycle is continuously repeated. Firefighters who were taking psychiatric medicine including sleeping pills, had other sleep disorders that can be the direct causes of sleep problems, such as apnea, were excluded from this study. The sample size was calculated using G-power 3.1.9.2 software, and the sample size was determined to be 99 persons by entering logistic regression, the two-tailed, an odds ratio of 2.89 [5], a α of .05, and a 1-β of .80. However, the drop-out rate was estimated to be 20% considering situations such as unexpected sick leaves and resignation. Although 119 firefighters initially expressed their intention to participate in the study, data from a total of 103 firefighters were finally used for analyses, because 10 firefighters were excluded due to a change of mind and annual leave, and 6 participants dropped out because of not wearing the actigraphy.

3. Measures

1) Insomnia and sleep quality

To objectively measure insomnia and sleep patterns, this study used a wristwatch-shaped actigraphy (ActiGraph wGT3X-BT) that can measure both sleep and the physical activity level simultaneously. According to the criteria presented by Carey et al. [8], insomnia measured by actigraphy refers to cases that satisfy two or more of the following four criteria: 1) sleep latency of 30 minutes or longer; 2) sleep efficiency of less than 85%; 3) total sleep time of less than 6 hours; 4) wake after sleep onset of 30 minutes or longer. A previous study reported that there were no significant differences between the mean value of the data measured by actigraphy for 3 days and the mean value of the data measured by actigraphy for a longer period (7 and 14 days), and that wearing compliance was decreased when an actigraphy was worn for 7 days or longer [21]. Therefore, in this study, participants were instructed to wear an actigraphy for three days during a day shift period to examine insomnia among firefighters. In addition to measurements by actigraphy, participants were requested to record the time of waking up and the time of going to bed in a self-report form by using a sleep log. They were also instructed to write the time and the reason for not wearing the actigraphy on the event record sheet when they could not wear it.

Sleep quality and subjective sleep patterns were assessed using a Korean version of the Pittsburgh Sleep Quality Index (PSQI) developed by Buysse et al. [22]. The Korean version of the PSQI used in this study was created by Cho et al. [23]. The first 4 items of this tool are self-report questions about the time of going to bed, sleep latency, wake-up time, and total sleep duration. Additionally, this instrument includes questions about various negative factors that may occur during sleep, the frequency of taking sleeping pills, sleepiness during daily activities, and difficulty in concentration, and these items are measured by giving 0 to 3 points according to the frequency. Finally, sleep quality is assessed by giving 0 to 3 points. The total scores of the PSQI range from 0 to 21 points, and higher scores indicate higher levels of severity of sleep problems. Persons with a total PSQI score of 5 points or higher are classified as 'poor sleepers' [22,23]. The Cronbach's α of the original instrument was .83 [22], and Cronbach's α was .75 in this study.

2) Physiological factor: physical illness status

The physical illness status was assessed by examining the presence or absence of cardiovascular, gastrointestinal,

endocrine, respiratory, and musculoskeletal diseases, which are diseases with high incidence rates among firefighters due to the nature of their job duties [2,5,8,30]. The physical illness status was examined using a sociodemographic questionnaire. If they have visited a hospital due to cardiovascular, gastrointestinal, endocrine, respiratory, or musculoskeletal diseases or there have been abnormal findings about these diseases in their health check-ups within the past year, the participants were asked to answer 'Yes', and if not, they were asked to respond 'No'.

3) Psychological factors: depression, anxiety, and occupational stress

Depression and anxiety were measured using a Korean-translated and modified version of the Patient Reported Outcome Measurement Information System-Short Form (PROMIS-SF) developed by the National Institutes of Health (NIH) [24]. The K-PROMIS used in this study was created by Choi et al. [25]. Each of the depression and anxiety assessment scales used in this study is composed of a total of 8 items. Each item is measured on a 5-point Likert scale, and the total scores range from 10 to 90 points. In addition, the levels of depression and anxiety can be assessed based on the mean T-score of 50 points (SD: 10 points), and higher scores indicate more severe depressive or anxiety symptoms [24,25]. The creators of the depression and anxiety assessment scales reported the Cronbach's α values of the tools as .92 and .89, respectively [24]. In this study, the Cronbach's α values of the depression and anxiety assessment tools were .87, and .87, respectively.

The level of occupational stress was measured using the Korean Occupational Stress Scale-Short Form (KOSS-SF) developed by Jang et al. [26]. This occupational stress assessment tool is composed of a total of 24 items and 7 domains derived through factor analysis. The 7 domains are as follows: job demand, insufficient job control, interpersonal conflict, job insecurity, organizational system, lack of reward, and occupational climate. Each item is measured on a 4-point Likert scale ranging from 1 to 4 points, and Questions 3, 5, 6, 7, 8, 9, 10, 11, 14, 15, 16, 17, 18, 19, and 20 are reverse scored. Higher scores indicate higher levels of occupational stress, and clinically, 55 or higher points are considered to indicate the necessity for interventions [26]. The Cronbach's α of the original instrument was .83 [26], and the Cronbach's α of this study was .84.

4) Situational factors: physical activity level, drinking, smoking, and social support

The level of physical activity was measured by actigraphy for 3 days, and the measured data of physical activity level was analyzed using Actilife 6, a software program. The level of physical activity can be divided into the following four levels: sedentary physical activity (<1.5 MET's), light physical activity (1.5≤MET's<3), moderate physical activity (3≤MET's<6), and vigorous physical activity (6≤MET's<9) [17].

In this study, current drinking status and the amount of alcohol consumed per week were examined, and only the amount of alcohol consumed per week was used in the analysis. The participants who were current drinkers were asked to write the amount of alcoholic beverages they consumed per week, and those who did not drink were asked to write '0.' The amount of alcohol consumed per week (g) was presented by converting the total amount of alcoholic beverages consumed per week into the total amount of alcohol consumed per week in units of grams (g) by taking into account the alcohol concentration of each alcoholic beverage consumed.

In addition, the current smoking status and the amount of smoking per week of the participants were examined, and the data of the amount of smoking per week was used in the analysis. The participants who were current smokers were asked to write the amount of smoking per week in units of packs, and those who did not smoke were asked to mark the amount as '0.'

Perceived social support was assessed using a Korean-translated, modified version of the Multidimensional Scale of Perceived Social Support (MSPSS) developed by Zimet et al. [27]. The Korean version was created by Seo & Koo [28]. This social support assessment scale consists of a total of 12 items, and includes 4 items in each of the 3 subdomains as follows: 4 items on the support of family members (Questions 3, 4, 8, and 11), 4 items on the support of friends (Questions 6, 7, 9, and 12), and 4 items on the support of significant others (Questions 1, 2, 5, and 10). Each item was measured on a 5-point Likert scale ranging from 1 point='Not at all' to 5 points='Very much.' Higher scores indicate higher levels of social support. The Cronbach's α of the original instrument was .88 [28], and Cronbach's α was .94 in this study.

4. Data Collection

This study was conducted after obtaining approval from the IRB of Seoul National University (IRB No. 1801/001-002). Data collection was carried out from January 16 to February 26, 2018. The researcher received prior permission from the administrative manager of the relevant fire station and the head of the relevant 119 safety center, and participants that met the inclusion criteria were re-

cruited with the cooperation of the officials of the fire station and the 119 safety center. In addition, this study was conducted after receiving written informed consent from the participants after giving them detailed explanations about the purpose and procedure of this study. The participants were also provided with explanations about confidentiality, anonymity, privacy, and the possibility of withdrawal from the study at any time. The participants were given a gift certificate as a token of appreciation.

5. Statistical Analysis

The collected data was analyzed using the SPSS 23.0 program. (1) The sociodemographic characteristics, the presence of insomnia, physiological factors, psychological factors, and situational factors were analyzed by using descriptive statistics and frequency analyses. (2) The mean values of the total sleep duration and sleep latency were calculated to compare sleep patterns measured by two kinds of measurement methods. (3) The t-test and hierarchical logistic regression analysis were performed to identify factors affecting insomnia and sleep quality among the participants. (4) The reliability of each assessment tool was assessed by calculating the Cronbach's α values, and the threshold for statistical significance was set at $p < .05$.

RESULTS

1. Sociodemographic Characteristics of Participants

As to gender, males were 97 persons (94.2%), and the mean age of the participants was 38.94±8.81 years. In marital status, 78 persons (75.7%) were married, and regarding the educational level, college graduates or above were 46 persons, accounting for the largest proportion (44.6%). In terms of the job position, the participants were composed of diverse job positions as follows: 23 firefighters (22.3%), 27 senior fire sergents (26.2%), 24 fire sergents (23.3%), and 26 fire lieutenants (25.2%). As to the type of specific job duty, fire suppression accounted for the largest proportion (56 persons, 54,4%). For working hours per week, 50 hours or less accounted for the largest proportion (49 persons, 47.5%) (Table 1).

Table 1. Socio-demographic Variables of the Participants (*N*=103)

Variables	Categories	n (%) or M±SD
Gender	Male	97 (94.2)
	Female	6 (5.8)
Age (year)		38.94±8.81
Marital status	Single	25 (24.3)
	Married	78 (75.7)
Number of children	0	33 (32.0)
	1	20 (19.4)
	≥2	50 (48.6)
Level of education	≤High school	16 (15.5)
	Dropping out of university	9 (8.7)
	Junior college graduate	32 (31.1)
	University graduate	44 (42.7)
	≥Graduate school	2 (1.9)
Position	Firefighter	23 (22.3)
	Senior fire sergent	27 (26.2)
	Fire sergent	24 (23.3)
	Fire lieutenant	26 (25.2)
	≥Fire captain	3 (2.9)
Period of continuous service (year)	≤5	30 (29.1)
	6~10	25 (24.3)
	11~15	19 (18.4)
	≥16	29 (28.2)
Assigned task	Fire suppression	56 (54.4)
	Paramedic	22 (21.4)
	Rescue	25 (24.3)
Duty hours (per week)	≤50	49 (47.5)
	51~60	39 (37.9)
	61~70	15 (14.6)

2. Sleep and Factors affecting Sleep

The analysis results of actigraphy data indicated that 66 participants (64.1%) suffered from insomnia, and 61 participants (59.2%) were classified as 'poor sleepers' with a PSQI score. Regarding objective sleep patterns measured by actigraphy, the mean total sleep time and the mean sleep latency were 352.31±55.13 minutes and 4.48±5.63 minutes, respectively. Meanwhile, the mean total sleep time and the mean sleep latency measured by self-reports were 401.00±55.00 minutes and 21.60±15.00 minutes, respectively. Thus, it was found that the total sleep time and sleep latency measured by subjective reports were longer than the measured values obtained by the objective method (Table 2).

With respect to the physical illness status, a total of 32 participants (31.1%) had one or more physical illness. In terms of psychological factors, the scores for depression and anxiety were 42.54±5.91 points and 42.50±6.83 points, respectively. Also, 32 participants (31.1%) were found to need an intervention for reducing occupational stress. As for situational factors, for the level of physical activity, seden-

tary physical activity made up 49.45±6.86% of the total physical activities, accounting for the largest proportion. Regarding drinking status, 74 persons (71.8%) were current alcohol drinkers, and the average amount of alcohol consumed per week was 84.52±94.34 gram. As for smoking status, 32 persons (31.1%) were current smokers, and the average amount of smoking per week was 1.49±2.51 pack. The mean score for perceived social support was 49.00±6.42 points (Table 2).

3. Factors affecting Insomnia

To identify factors related to insomnia, hierarchical logistic regression analysis was performed by sequentially entering sociodemographic characteristics, physiological, psychological, and situational factors. The results are as follows (Table 3). In the case of physical activity, multicollinearity among sedentary, light, and moderate physical activity was suspected, so only sedentary physical

Table 2. Sleep, Physiologic, Psychologic, Situational Variables of the Participants (*N*=103)

Variables		Categories		n (%) or M±SD
Sleep	Objective results			
	Insomnia	Yes		66 (64.1)
		No		37 (35.9)
	Sleep pattern	Sleep duration (min)		352.31±55.13
		Sleep efficiency (%)		84.79±6.60
		Sleep latency (min)		4.48±5.63
		Wake after sleep onset (min)		59.50±29.18
	Subjective results			
	Pittsburgh Sleep Quality Index	≥5		61 (59.2)
		<5		42 (40.8)
				5.65±2.57
	Sleep pattern	Bed time (hh:mm)		23:46±1.60
		Sleep latency (min)		21.60±15.00
		Awake time (hh:mm)		07:03±36.00
		Total sleep time (min)		401.00±55.00
Physiologic factors	Physical illness status	Yes		32 (31.1)
		Cardiovascular		3 (2.9)
		Digestive		13 (12.6)
		Endocrine		7 (6.8)
		Respiratory		3 (2.9)
		Musculoskeletal		17 (16.5)
		No		71 (68.9)
Psychologic factors	Depression			42.54±5.91
	Anxiety			42.50±6.83
	Occupational stress	Yes (≥55)		32 (31.1)
		No (<55)		71 (68.9)
				51.13±7.17
Situational factors	Physical activity level (%)		Sedentary	49.45±6.86
			Light	34.86±10.28
			Moderate	15.69±9.24
	Alcohol	Yes		74 (71.8)
			Gram (per week)	84.52±94.34
		No		29 (28.2)
	Smoking	Yes		32 (31.1)
			Pack (per week)	1.49±2.51
		No		71 (68.9)
	Social support			49.00±6.42

Table 3. Factors Influencing Insomnia on Logistic Analysis (*N*=103)

Factors	Variables (baseline)	Categories	Model 1	Model 2	Model 3	Model 4
			OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Socio-demographic	Age		1.07 (0.93~1.22)	1.07 (0.94~1.23)	1.06 (0.92~1.22)	1.06 (0.91~1.24)
	Marital status (single)	Married	1.03 (0.24~4.44)	1.04 (0.24~4.47)	1.06 (0.24~4.66)	0.83 (0.17~4.16)
	Period of continuous service (≥16 years)	≤5	4.14 (0.21~83.51)	4.19 (0.21~85.61)	4.82 (0.22~104.04)	2.36 (0.09~65.71)
		6~≤10	2.72 (0.34~21.42)	2.82 (0.36~22.22)	2.61 (0.31~21.72)	1.36 (0.13~14.21)
		11~≤15	3.16 (0.50~19.91)	3.35 (0.53~21.13)	2.92 (0.43~19.67)	2.24 (0.27~18.49)
	Assigned task (fire suppression)	Paramedic	2.80 (0.79~10.00)	2.75 (0.77~9.88)	2.84 (0.77~10.44)	4.28 (1.02~17.92)*
		Rescue	0.94 (0.32~2.78)	0.97 (0.33~2.87)	1.09 (0.35~3.38)	1.00 (0.28~3.54)
	Duty hours (≤50, per week)	51~≤60	0.68 (0.24~1.92)	0.63 (0.22~1.82)	0.70 (0.24~2.08)	0.60 (0.18~1.99)
		61~≤70	0.50 (0.13~2.01)	0.50 (0.12~2.00)	0.63 (0.15~2.64)	1.36 (0.27~6.84)
Physiologic	Physical illness status (no)	Yes		0.61 (0.25~1.51)	0.57 (0.23~1.45)	0.49 (0.17~1.39)
Psychologic	Depression				0.93 (0.84~1.03)	0.92 (0.82~1.03)
	Anxiety				1.09 (0.99~1.20)	1.12 (1.01~1.24)*
	Occupational stress				1.03 (0.96~1.11)	1.05 (0.97~1.13)
Situational	Sedentary					0.85 (0.78~0.94)*
	Alcohol					1.00 (0.99~1.00)
	Smoking					1.07 (0.87~1.31)
	Social support					1.00 (0.91~1.09)
Hosmer & Lemeshow x^2 (p)			3.87 (.87)	8.09 (.43)	1.16 (.99)	4.67 (.79)
Neglkerke R^2			.06	.08	.13	.31

CI=confidence interval, OR=odds ratio; *p <.05.

activity was entered as an independent variable because it was found to be a significant variable by the t-test. In Model 1, sociodemographic characteristics were entered, and in Model 2, a physiological factor was additionally entered. In Model 3, psychological factors were additionally entered. In these three regression models, there were no significant variables related to insomnia. However, in Model 4 where situational factors were additionally entered, paramedic (p=.046), anxiety (p=.039), and sedentary physical activity (p=.001) were identified as statistically significant variables. The likelihood of insomnia was 4.28 times higher in the group performing paramedic activities than in the group performing fire suppression activities. Also, firefighters with anxiety were 1.12 times more likely to have insomnia than those without anxiety. As sedentary physical activity increased by 1%, the likelihood of insomnia became lower by 0.85 times. The explanatory power of these variables was 31.2%.

4. Factors affecting Sleep Quality

To identify the factors associated with sleep quality, hierarchical logistic regression analysis was performed by sequentially entering sociodemographic characteristics, a physiological, psychological, and situational factors. The results are as follows (Table 4). In Model 1 where sociodemographic characteristics were entered, working hours per week was found to be a significant (p=.036). In Model 2 where a physiological factor was additionally entered, the physical illness status was found to be a statistically significant (p=.011). In Model 3 where psychological factors were additionally entered, the physical illness status was a statistically significant (p=.016). In Model 4 where situational factors were additionally entered, the physical illness status (p=.008) and social support (p=.003) were identified as statistically significant, and the explanatory power of these variables was 40.3%. Firefighters with at

Table 4. Factors Influencing Poor Sleep Quality on Logistic Analysis (*N*=103)

Factors	Variables (baseline)	Categories	Model 1	Model 2	Model 3	Model 4
			OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Socio-demographic	Age		0.99 (0.87~1.13)	0.98 (0.85~1.12)	0.94 (0.82~1.09)	0.88 (0.75~1.04)
	Marital status (single)	Married	1.45 (0.33~6.38)	1.54 (0.32~7.43)	1.75 (0.33~9.32)	2.05 (0.31~13.63)
	Period of continuous service (≥16 years)	≤5	1.92 (0.10~37.42)	1.83 (0.08~41.72)	1.66 (0.07~42.48)	0.89 (0.02~32.79)
		6~10	1.14 (0.15~8.80)	0.99 (0.11~8.73)	0.79 (0.08~7.99)	0.47 (0.04~5.70)
		11~15	1.51 (0.25~9.20)	1.29 (0.19~8.69)	0.94 (0.12~7.21)	0.49 (0.05~4.49)
	Assigned task (fire suppression)	Paramedic	1.11 (0.35~3.55)	1.17 (0.36~3.85)	1.15 (0.33~4.00)	0.76 (0.18~3.16)
		Rescue	0.89 (0.29~2.71)	0.79 (0.25~2.53)	1.03 (0.30~3.50)	0.85 (0.23~3.18)
	Duty hours (≤50, per week)	51~60	0.33 (0.12~0.93)*	0.35 (0.12~1.02)	0.38 (0.12~1.15)	0.28 (0.08~1.03)
		61~70	0.63 (0.16~2.46)	0.61 (0.15~2.44)	0.67 (0.15~3.00)	0.77 (0.13~4.61)
Physiologic	Physical illness status (no)	Yes		3.74 (1.36~10.32)*	3.75 (1.28~10.94)*	5.17 (1.53~17.51)*
Psychologic	Depression				1.07 (0.96~1.20)	1.11 (0.99~1.25)
	Anxiety				1.01 (0.92~1.10)	1.00 (0.90~1.10)
	Occupational stress				1.07 (0.99~1.15)	1.01 (0.93~1.10)
Situational	Sedentary					1.01 (0.93~1.09)
	Alcohol					1.00 (0.99~1.00)
	Smoking					1.08 (0.88~1.33)
	Social support					0.86 (0.78~0.95)*
Hosmer & Lemeshow x^2 (p)			3.51 (.90)	8.59 (.38)	6.15 (.63)	3.42 (.91)
Neglkerke R^2			.09	.17	.26	.40

CI=confidence interval, OR=odds ratio; *p <.05.

least one physical illness were found to be 5.17 times more likely to have poor sleep quality than those without physical illness. Also, as the score for social support increased by 1 point, the likelihood of poor sleep quality became lower by 0.86 times among firefighters.

DISCUSSION

1. Sleep Patterns among Firefighters

In this study, the sleep patterns of firefighters were examined by subjective and objective measurement tools, and the results showed that the prevalence of insomnia among the participants was 64.1% and sleep quality was poor in 59.2%. According to a foreign study using actigraphy, they reported that the prevalence of insomnia was 36% [8]. But it is not possible to compare the prevalence rate of this study with other studies in Korea since there is a lack of similar studies. In comparison with the results of a foreign study, a higher prevalence of insomnia in this study can be attributed to the fact that only firefighters who performed tasks such as fire suppression, paramedic, and rescue and worked in shifts were included in this study, excluding administrative officers, and Korean firefighters have different work environments and shift patterns than firefighters in other countries. On the other hand, the sleep quality of firefighters measured in this study was found to be better than the one reported in other studies conducted in Korea or a foreign country [8,12]. In this connection, Jeong et al. [9] reported that sleep quality was better in the group working day shifts than in the group working night shifts. In view of the findings of Jeong et al. [9], this is possibly due to the fact that this study conducted a survey among firefighters who were working day shifts.

2. Comparison between Objective and Subjective Sleep Patterns among Firefighters

In this study, the self-reported total sleep duration and sleep latency values were longer than the objectively measured values. However, according to a study on compar-

isons between the subjectively reported and objectively measured data on sleep duration among insomnia patients [15], the self-reported total sleep duration was shorter than the measured value, and the self-reported total sleep duration was shorter in the participants who complained of higher levels of insomnia. In other words, the previous study presented findings that are in contrast with the results of this study. The reasons for this disparity in this study is presumed to be following factors. First, the disagreement in study findings may be related to differences in the characteristics of participants. In this study, persons diagnosed with psychiatric diseases and those taking sleeping pills were excluded. In contrast, Kim et al. [15] investigated sleep among adult patients with insomnia. In their study, the percentage of participants with insomnia or psychiatric diseases was 43%, and persons with insomnia or psychiatric diseases were reported to have a tendency to perceive the total sleep duration to be relatively shorter than the actual total sleep duration [15]. Differences in the perception of the total sleep duration are commonly observed not only in the normal sleep group but also in the insomnia group, and factors affecting these differences include age, perception about the depth of sleep, and psychiatric diseases [14,15]. In addition, since there are conflicting views about the differences between objectively measured and subjectively reported sleep durations and factors associated with them, there is a need to conduct repetitive studies on these issues [15]. The second reason for the disparity may be found in the difference in the measurement periods of the two measurement methods. In a previous study [19], when the measurement periods were identical, there was a strong correlation between the objectively and subjectively measured total sleep durations. In this study, the measurement period was 3 days for objective measurements and 1 month for subjective measurements. In general, when objective and subjective measurement periods were different as in this study, there was a lower correlation between subjectively and objectively measured values. Meanwhile, it has been reported that persons who experience more sleep problems tend to report a longer subjective sleep latency than the actual sleep latency and thus rate their sleep quality as poorer [14,15]. These findings are in agreement with the results of this study showing that firefighters showed poor sleep quality and a long sleep latency.

The results of this study showed a disparity in the mean values of objectively measured and subjectively reported sleep patterns among firefighters, and the review of several previous studies [14,15] showed that self-reported sleep patterns were often in disagreement with objective findings. Nevertheless, since subjective sleep patterns reflect sleep satisfaction, restorative feeling after sleep, health status, and quality of life, it is required to measure sleep patterns by both methods in order to evaluate sleep states as accurately as possible. In addition, it is necessary to investigate objective and subjective sleep patterns by using identical periods so as to eliminate discrepancies in measured values due to the use of the different measurement periods.

3. Factors affecting Sleep among Firefighters

In this study, the likelihood of insomnia was 4.28 times higher in the group of firefighters in charge of paramedic activities than in the group in charge of fire suppression. In this regard, it has been reported that the dispatch frequency is 9 times higher in the group of paramedic than fire suppression, and higher dispatch frequencies are associated with higher levels of stress and higher risk for mental health [30]. Moreover, in the case of paramedic, there are concerns that they may suffer from chronic sleep deprivation because there arise situations in which they have little or no time for sleep due to frequent dispatches during night shifts or watch duty [6]. The results of this study also showed that sleep quality was poorer in the group of paramedic than in groups in charge of other duties. These findings indicate that paramedic have the most serious sleep problems among firefighters.

In this study, it was found that firefighters with anxiety are 1.12 times more likely to have insomnia. This finding is consistent with a previous study which reported that anxiety was commonly observed in firefighters, and the prevalence of anxiety was 3 times higher in firefighters with sleep disorders than in those without sleep disorders [2]. In particular, since anxiety increases the possibility of the development of other mental disorders, there is a need for active interventions through screening for early detection and treatment of anxiety [1,2].

As sedentary physical activity increased by 1 % in firefighters, the likelihood of the occurrence of insomnia became 0.85 times lower. These results are thought to indicate that less physical activity and a longer sedentary time are associated with better sleep. However, a prior study reported that the level of physical activity was not related to the total sleep duration among firefighters [18]. In addition, another previous study reported that it is difficult to accurately determine causal relationships between sleep disorders and the level of physical activity [11]. In a previous study that measured the physical activity of firefighters fighting forest fires for several days [17],

the proportions of light (66%) and moderate physical activity (23%) were relatively higher, while the proportion of sedentary (11%) was relatively lower. However, in this study, sedentary physical activity accounted for 49.45% of the total physical activities. Thus, the difference in the proportions of physical activities is presumed to be one of the reasons that the results of this study are not in agreement with those of previous studies, and a longer sitting time is thought to indicate a lower dispatch frequency, less dispatch time, and more waiting time during the measurement period. Vincent et al. [17] also mentioned that the level of physical activity may vary depending on factors such as the duration and seriousness of disaster sites and exposure to smoke and heat. Therefore, it is necessary to conduct repeated studies on the physical activity level of firefighters to explicate the reasons for differences in study findings regarding the association between physical activity and sleep.

In this study, firefighters with one or more physical illness were found to be 5.17 times more likely to have poor sleep quality. Cardiovascular, endocrine, gastrointestinal, musculoskeletal and respiratory diseases are reported to occur frequently among firefighters [2,5,8,30], and this study also found that 31.1% of the participants had one or more physical illness. In addition, since firefighters usually sleeping for less than six hours per day are at higher risk for cardiovascular diseases, gastrointestinal diseases, obesity, diabetes, and sleep apnea, it is required to perform early diagnosis and treatment and detect high-risk groups through continuous attention and periodic checkups [2,8].

In this study, as the score for social support increased by 1 point, the likelihood of poor sleep quality became 0.86 times lower. A previous study also reported that social support is related to sleep quality among firefighters [8]. In particular, social support is not only a factor related to sleep but also a significant mediating variable between occupational stress and quality of life [10]. More specifically, it has been shown that a higher level of occupational stress is associated with a lower level of social support, but increased social support is related to a higher level of quality of life [10]. Firefighters are an occupational group with a stronger bond among colleagues than other occupational groups as they work together in the field for a long time [8]. Since social support affects firefighters' mental health as well as their physical health, it is necessary to promote constant conversations and mutual encouragement between colleagues based on respect among firefighters.

The results of this study demonstrated that physiological, psychological and situational factors influence sleep among firefighters. However, it is notable that factors affecting insomnia were not identical to factors influencing sleep quality in this study. Factors affecting insomnia derived by objective methods were psychological and situational factors, and factors associated with sleep quality identified by subjective evaluation were physiological and situation factors. In previous studies on factors related to sleep among firefighters conducted so far, sleep patterns and factors affecting sleep were investigated only with subjective questionnaire tools, [5,12], and this approach is thought to have difficulty in exploring the multidimensional aspects of sleep. Moreover, since a previous study reported that there was a low association between objective and self-reported sleep states [15], there is a need to utilize both measurement methods to investigate sleep patterns.

The major outcomes of this study can be summarized as follows. First, this is the first research attempt to examine sleep in firefighters in Korea in a multifaceted and integrated manner with two measurement methods. Second, this study tried to bring national attention to the health of firefighters, and presented the future directions of the operation of firefighters' organization, and the roles of healthcare providers. However, this study has some limitations. First, it is hard to generalize since this study was conducted with firefighters who were selected by convenience sampling. Second, there is a possibility that there is a low correlation between two types of sleep patterns, since the measurement period was different.

CONCLUSION

This study is a cross-sectional, descriptive survey research to investigate the presence of insomnia, sleep quality, and compare the mean values of objective and subjective sleep patterns, and identify factors affecting sleep among firefighters. The results of this study indicated that objective sleep patterns and self-reported sleep states are both poor among firefighters. In addition, it was found that both the total sleep duration and sleep latency measured by a self-report scale were longer than objectively measured values. Further, physiological, psychological, and situational factors were found to be influencing factors for sleep among firefighters.

In particular, in relation to differences between objective and subjective sleep patterns, it is necessary to examine the degree of agreement between the measurement results by using the same measurement periods in future studies. In addition, further research is needed to investigate the dispatch frequency and dispatch time according

to the duty of firefighters, and thereby examine the relationship between physical activity level and sleep. Further, it is necessary to conduct a structural model research to examine the relationship between factors affecting insomnia and factors influencing sleep quality among firefighters and comprehensively investigate the paths affecting sleep. This future work is expected to contribute to the strategies that can improve both the quantity and quality of sleep among firefighters. Additionally, it is necessary to establish a system for treatment of firefighters who complain of anxiety or have physical disease and allow them to have additional medical examinations in addition to regular check-ups. To this end, it is necessary to increase national attention and develop and implement the required systems and policies. Lastly, to enhance social support among firefighters, it is suggested to hold regular meetings or organize programs that will help and encourage firefighters to continuously provide social support to each other through consideration toward each other and open conversations with colleagues and superiors.

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