Sleep Quality and Associated Factors Among Firefighters in Bangkok, Thailand: A Cross-sectional Study

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Objectives: Professional firefighters face various health hazards and are required to maintain both physical and mental fitness to effectively mitigate crises and respond to emergencies. Moreover, the long working hours and shift work of this profession impact sleep quality. This study investigated the quality of sleep and its associated factors among firefighters in Bangkok, Thailand.

Methods: This was a cross-sectional study of firefighters affiliated with the Bangkok Fire and Rescue Department, Bangkok Metropolitan Administration, Thailand between January 2023 and March 2023. A cluster random sampling technique was utilized to distribute 600 questionnaires to firefighters in 15 fire stations. The questionnaire addressed demographic, work-related, and environmental factors. Sleep quality was assessed using the Thai version of the Pittsburgh Sleep Quality Index (PSQI). Data analysis involved both descriptive and inferential statistics. Bivariate and multiple logistic regressions were performed.

Results: The response rate was 78.7% (n=472), and 44.1% of the firefighters reported poor sleep quality (PSQI score >5). Sleep quality was statistically associated with conflicting family relationships (odds ratio [OR], 1.8; 95% confidence interval [CI], 1.1 to 2.9), additional part-time jobs (daytime, OR, 2.4; 95% CI, 1.3 to 4.4; or nighttime, OR, 4.3; 95% CI, 1.1 to 16.7), noisy sleeping areas (OR, 1.7; 95% CI, 1.1 to 2.8), and the availability of adequate bedding (OR, 3.0; 95% CI, 1.8 to 4.9).

Conclusions: Poor sleep quality among firefighters was associated with various personal, work-related, and environmental factors. Organizations should promote policies that improve sleep quality through good sleep hygiene practices and facilities.

Key words: Sleep quality, Firefighters, Pittsburgh Sleep Quality Index, Thailand

INTRODUCTION

Healthy sleep is a fundamental factor in overall health and well-being and is crucial for a high quality of life. Sleep health has emerged as a vital health concern across all age groups, particularly among adults working in shift-based occupations or those experiencing sleep-related disorders [1]. Poor sleep quality is recognized as a global problem, and researchers from many countries have recognized the importance of studying this issue, particularly the various factors related to an individual's satisfaction with their sleep experience. A wide range of internal and external factors significantly influence sleep quality [2]. Poor sleep quality has been shown to have detrimental effects on the body, leading to feelings of fatigue, impaired work performance, decreased responsiveness, and inappropriate health behaviors [3].

In the realm of occupational health, the International Labor Organization asserts that sleep health has a multifaceted impact on both health and work performance, particularly in

terms of safety. It recommends that employers actively address this issue and assist employees within their organizations with a focus on policy formulation and implementation [4].

Firefighters face multiple health hazards in the physical, chemical, biological, psychological, and sociological domains of their work. Consistently high work performance is also required of them to effectively respond to emergencies and mitigate disaster and crisis situations. This profession generally entails long working hours and shift work that significantly impacts the quality of sleep for these workers [5]. A recent systematic review of poor sleep quality among firefighters showed a scarcity of studies from low-income and middle-income countries, which represented only 3 studies of 14 studies (2 in Iran and 1 in Thailand) [6]. The study by Khumtong and Taneepanichskul [7] in Thailand focused on mental health issues among Bangkok firefighters and revealed that 49% of participants reported poor sleep quality. However, there was limited analysis of the relationship between sleep quality and other related factors, particularly shift work. The present study aimed to investigate both sleep quality and its related factors among firefighters in Bangkok, Thailand.

METHODS

Study Setting and Population

The participants in this study were randomly selected from all firefighters affiliated with the Bangkok Fire and Rescue Department, Bangkok Metropolitan Administration (BMA). The total population consisted of 1740 individuals, distributed across 6 firefighting and rescue operation divisions encompassing 37 stations. A sample size of 394 was calculated for the target population using the sample size for a finite population formula [8]. The study employed cluster sampling targeting all firefighters in 15 randomly selected fire stations where the survey was distributed. The final total of selected officers in these stations was 600.

Data Collection

The questionnaire on sleep quality and the related factors among firefighters in Bangkok consisted of 3 sections (Supplemental Material 1).

Section 1

Demographic characteristics, including age (years), body mass index (BMI, kg/m^2), waist circumference (cm), caffeine consumption (never, occasionally, and daily), smoking (never, ever, current), exercise history (days per week that the individual exercised for at least 30 minutes), history of non-communicable diseases (diagnosis of diabetes, hypertension, dyslipidemia, or cardiovascular diseases by a physician), mental health issues (had consulted with medical professionals regarding stress, depression, or anxiety), and family relationships (overall relationship with family members, good or conflicted).

Section 2

Work-related factors and environmental factors in the workplace, including work experience (years) [9]; income [10]; job positions (aligned with education level); part-time work in addition to being a full-time firefighter, either daytime (8 a.m. to 8 p.m.) or nighttime (8 p.m. to 8 a.m.); shift patterns including discontinuous shifts (a break of ≥24 hours between shifts) and continuous shifts (a break of <24 hours between shifts); main sleep accommodation during work shifts (on-call room, dormitory, and home); issues related to excessive noise and lighting conditions in sleeping quarters; and concerns regarding the provision of adequate bedding.

Section 3

To assess sleep quality, we used the Pittsburgh Sleep Quality Index (PSQI) [11], which had undergone forward and backward translation to establish a standardized Thai version [12]. The PSQI consists of 19 questions to assess the 7 components of sleep quality within the past month. These components include subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction. Each component was scored on a scale of 0 (excellent) to 3 (poor), with a total score ranging from 0 to 21. An overall score >5 indicated poor sleep quality.

Data from the questionnaires administered to the sample group were collected from January 2023 to March 2023. The participants were contacted through communication with their station supervisors, and the researchers themselves collected the questionnaires. The questionnaire took approximately 20 minutes to complete.

Statistical Analysis

A descriptive statistical analysis of the demographic characteristics, work-related factors, and environmental factors in the workplace was conducted. The analysis utilized frequency and percentage distributions to examine levels of sleep quality

based on the 7 components of the PSQI questionnaire. Total scores ranged from 0 points to 21 points and were categorized into 2 groups based on the total score and the sleep quality assessment criteria derived from the original scale: poor sleep quality (>5 points) and good sleep quality (≤5 points). The results were presented using frequency and percentage distributions.

Inferential statistics were utilized to compare sleep quality with the qualitative data factors using statistical tests such as the chi-square test and the Fisher exact test. Variables with a p-value <0.05 and/or related to sleep quality per a literature review were then included in the multiple logistic regression analysis to identify the factors associated with sleep quality. The significance level for this study was set at p-value <0.05. Data analysis was performed using Stata version 16.0 (Stata-Corp., College Station, TX, USA).

Ethics Statement

This was a cross-sectional descriptive study. The study design and its ethical considerations were approved by the Institutional Review Board of the Faculty of Medicine, Chulalongkorn University (Med Chula IRB No. 0873/65).

RESULTS

Of the 472 participants who took part in this study (78.7% response rate), all were male with an average age of 42.5 years. The majority were under 45 years of age (59.7%). These results were not significantly different than the characteristics of all BMA firefighters (average age 44.0 years and all male). Furthermore, a significant proportion had an overweight BMI (70.8%), a waist circumference <90 cm (70.1%), and reported good family relationships (79.5%) (Table 1).

Regarding work-related factors, the majority (51.7%) had work experience ≥14 years and earned a minimum income of ≥26 000 Thai baht (50.4%). Moreover, most participants did not engage in overtime work or have extra part-time jobs (84.3%), while their work schedules followed a discontinuous shift pattern with a minimum 24-hour break (77.8%). Regarding environmental factors in the workplace, 48.3% reported sleeping in designated on-call rooms during their work shifts. The identified issues with these sleeping areas were the presence of noise (27.3%), excessive lighting (10.4%), and a problem with the availability of adequate bedding (23.9%) (Table 2).

A summary of the sleep quality scores is presented in Table 3.

Table 1. Demographic characteristics of firefighters in Bangkok, Thailand in a study of sleep quality (n=472)

Characteristics	n (%)
Age (y)	
<45	282 (59.7)
≥45	190 (40.3)
Body mass index (kg/m²)	
Normal (18.5-22.9)	134 (28.4)
Underweight (<18.5)	4 (0.8)
Overweight (≥23.0)	334 (70.8)
Waist circumference (cm)	
<90	331 (70.1)
≥90	141 (29.9)
Non-communicable diseases[1]	
Yes	87 (18.4)
Mental health issues[2]	
Yes	8 (1.7)
Caffeine consumption	
Never	114 (24.1)
Occasionally	218 (46.2)
Daily	140 (29.7)
Smoking	
Never	216 (45.8)
Ever	125 (26.5)
Current	131 (27.7)
Physical exercise (day/wk)	
0-4	427 (90.5)
≥5	45 (9.5)
Family relationship	
Good	375 (79.5)
Conflicting	97 (20.5)

[1]Includes physician-diagnosed diabetes, hypertension, dyslipidemia, and cardiovascular diseases.
[2]Consulted with medical professionals regarding stress, depression, or anxiety.

Most participants demonstrated good subjective sleep quality (53.4%). Sleep latency also received favorable scores (44.7%). Most individuals reported a sleep duration of 6-7 hours, which falls within the category of good sleep (51.5%). Habitual sleep efficiency was predominantly excellent (52.3%). Sleep disturbances were mostly low (63.6%), and the use of sleep medications was infrequent during the past month, indicating very good sleep practices (91.5%). Daytime dysfunction received low scores, indicating good overall functioning during the day (55.9%). The average overall sleep quality score for the sample was 5.7 (standard deviation, 3.3), with 208 participants (44.1%) experiencing 'poor' sleep quality.

According to bivariate analysis, significant statistical rela-

tionships were found between various personal factors and poor sleep quality levels. These factors included BMI ($p<0.05$),

Table 2. Work-related and environmental factors in a study of sleep quality among firefighters in Bangkok, Thailand (n=472)

Variables	n (%)
Work experience (y)	
≥14	244 (51.7)
<14	228 (48.3)
Income (Thai baht)	
≥26 000	238 (50.4)
<26 000	234 (49.6)
Job position (aligned with education level)	
Bachelor's degree or higher	89 (18.9)
Less than bachelor's degree	383 (81.1)
Part-time job (daytime)[1]	
No	398 (84.3)
Yes	62 (13.1)
Part-time job (nighttime)[1]	
No	398 (84.3)
Yes	16 (3.4)
Shift pattern	
Discontinuous shift (≥24-hr break)	367 (77.8)
Continuous shift (<24-hr break)	105 (22.3)
Sleeping accommodation during shift work	
On-call room	228 (48.3)
Dormitory	188 (39.8)
Home	56 (11.9)
Noisy sleeping area	
Yes	129 (27.3)
Excessive lighting in the sleeping area	
Yes	49 (10.4)
Adequate bedding availability	
Poor	113 (23.9)

[1]Works a part-time job in addition to the full-time job as firefighter.

waist circumference ($p<0.05$), non-communicable diseases ($p<0.05$), caffeine consumption ($p=0.007$), and family relationships ($p<0.05$). Furthermore, work-related factors and environmental factors in the workplace were also found to have statistically significant relationships with poor sleep quality levels. These factors included extra part-time jobs (overall, $p<0.001$; daytime, $p<0.001$; nighttime, $p=0.002$), shift patterns ($p=0.001$), noisy sleeping areas ($p<0.001$), excessive brightness in the sleeping areas ($p<0.05$), and problems with the availability of adequate bedding ($p<0.001$).

Results of the multiple logistic regression analysis are presented in Table 4. Conflicting family relationships (odds ratio [OR], 1.8; 95% confidence interval [CI], 1.1 to 2.9), extra part-time jobs both daytime (OR, 2.4; 95% CI, 1.3 to 4.4) and nighttime (OR, 4.3; 95% CI, 1.1 to 16.7), noisy sleeping areas (OR, 1.7; 95% CI, 1.1 to 2.8), and problems with the availability of adequate bedding (OR, 3.0; 95% CI, 1.8 to 4.9) were found to be significantly associated with a poor sleep quality level.

DISCUSSION

This study on sleep quality and related factors among our sample of firefighters had a response rate of 78.7%. A comparably good response rate (77.4%) was found in a previous study conducted on a similar sample group in Thailand [7] as well as in the study by Mehrdad et al. [9] in Iran (88.7%). In contrast, the study by Huang et al. [13] in Taiwan reported a response rate of 37.7%. This difference in return rates may be attributed to differences in the populations and the varying nature of shift work, which can make it challenging to recruit study participants and obtain high response rates.

The average overall sleep quality score of our sample was 5.7, with a poor sleep quality rate of 44.1%. In a study conduct-

Table 3. Sleep quality levels among firefighters in Bangkok, Thailand according to components of the PSQI (n=472)

Scores of PSQI components	Excellent (0)	Good (1)	Fair (2)	Poor (3)
Subjective sleep quality	107 (22.6)	252 (53.4)	99 (21.0)	14 (3.0)
Sleep latency	119 (25.2)	211 (44.7)	113 (24.0)	29 (6.1)
Sleep duration	118 (25.0)	243 (51.5)	58 (12.3)	53 (11.2)
Habitual sleep efficiency	247 (52.3)	126 (26.7)	71 (15.0)	28 (6.0)
Sleep disturbance	82 (17.4)	300 (63.6)	80 (17.0)	10 (2.0)
Use of sleep medications	432 (91.5)	24 (5.1)	11 (2.3)	5 (1.1)
Daytime dysfunction	264 (55.9)	182 (38.5)	21 (4.5)	5 (1.1)
PSQI total score, mean±SD		5.7±3.3		

Values are presented as number (%).
PSQI, Pittsburgh Sleep Quality Index; SD, standard deviation.

Table 4. Sleep quality and associated factors among firefighters in Bangkok, Thailand (n=472)

Variables	OR (95% CI)	aOR (95% CI)[1]
BMI (kg/m^2)		
Normal (18.5-22.9)	1.0 (reference)	1.0 (reference)
Underweight (<18.5)	5.7 (0.6, 56.7)	2.7 (0.2, 31.7)
Overweight (≥23.0)	1.7 (1.2, 2.6)*	1.2 (0.8, 2.0)
Waist circumference (cm)		
<90	1.0 (reference)	1.0 (reference)
≥90	1.5 (1.0, 2.2)*	1.2 (0.7, 1.9)
Chronic disease history		
No	1.0 (reference)	1.0 (reference)
Yes	1.7 (1.1, 2.8)*	1.4 (0.8, 2.3)
Caffeine consumption		
Never	1.0 (reference)	1.0 (reference)
Occasionally	1.9 (1.2, 3.1)*	1.5 (0.9, 2.6)
Daily	2.2 (1.3, 3.6)*	1.7 (0.9, 3.0)
Family relationship		
Good	1.0 (reference)	1.0 (reference)
Conflicting	1.6 (1.0, 2.5)*	1.8 (1.1, 2.9)*
Work experience (y)		
≥14	1.0 (reference)	1.0 (reference)
<14	0.7 (0.5, 0.9)*	0.7 (0.4, 1.1)
Additional part-time job (daytime)		
No	1.0 (reference)	1.0 (reference)
Yes	2.8 (1.6, 5.0)*	2.4 (1.3, 4.4)*
Additional part-time job (nighttime)		
No	1.0 (reference)	1.0 (reference)
Yes	5.8 (1.6, 20.6)*	4.3 (1.1, 16.7)*
Shift pattern		
Discontinuous shift (≥24-hr break)	1.0 (reference)	1.0 (reference)
Continuous shift (<24-hr break)	2.1 (1.3, 3.2)*	1.4 (0.8, 2.2)
Noisy sleeping area		
No	1.0 (reference)	1.0 (reference)
Yes	2.3 (1.5, 3.5)*	1.7 (1.1, 2.8)*
Excessive lighting in the sleeping area		
No	1.0 (reference)	1.0 (reference)
Yes	2.2 (1.2, 4.0)*	1.2 (0.6, 2.4)
Adequate bedding availability		
Good	1.0 (reference)	1.0 (reference)
Poor	3.9 (2.5, 6.2)*	3.0 (1.8, 4.9)*

OR, odds ratio; aOR, adjusted odds ratio; CI, confidence interval; BMI, body mass index.
[1]Adjusted for other variables including BMI, waist circumference, noncommunicable diseases, caffeine consumption, family relationships, work experience, extra part-time job (8 a.m. to 8 p.m.), extra part-time job after 8 pm, shift pattern, noisy sleeping area, excessive lighting in the sleeping area, and bedding availability.
*$p < 0.05$.

ed by Khumtong and Taneepanichskul [7] on firefighters in the same city, Bangkok, a similar poor sleep quality rate of 49.1% was observed. Notably, the level of sleep quality within their sample group showed a positive trend of improvement, which might be attributed to the fact that mental health issues identified in previous studies were being addressed. In addition, working environments were being improved, including the upgrading of fire stations with designated sleeping quarters for staff. Our findings were also similar to the study by Lim et al. [14] in Korea, which reported a poor sleep quality rate of 48.7%, possibly due to similar average age ranges and roles. It is noteworthy that the overall sleep quality scores found in this study differed from those in other countries that used translated versions of the PSQI questionnaire. This difference can be explained by variations in the characteristics of the studied populations, the nature of shift work, and the varying workload in each country. For instance, the study by Savall et al. [15] found a poor sleep quality rate of 29% in a sample group of firefighters where 71% were volunteer rescuers and not professional firefighters. This was lower than the findings in several countries. The study by Billings and Focht [16] in the United States reported a rate of 73%, possibly due to different shift work patterns in different geographic areas. The study by Mehrdad et al. [9] in Iran reported a rate of 69.9%, likely because the firefighters had less work experience (an average of 9.7 years) than in our study (13.4 years).

Our study showed a consistent relationship between family conflict and poor sleep quality, similar to the study of firefighters by Watkins et al. [17]. Both studies found that receiving social support from family, friends, and colleagues, as well as having good relationships within the family were associated with better sleep quality. This could be attributed to a reduction in psychological pressure and stress, leaving more time and attention to devote to good sleep hygiene. Also reported that subjectively healthy relationships contributed to improved sleep quality [18].

The firefighters involved in this study were affiliated with the BMA, which had issued guidelines suggesting a 24-hour break after firefighters' shifts. However, these guidelines were not legally binding, and firefighters were not prohibited from engaging in irregular part-time work. During data collection, it was observed that firefighters often took on additional work during their breaks, such as driving for food and product delivery services or engaging in family/local business activities. This practice potentially infringed on their resting and sleeping

time. Our study found that individuals who engaged in extra part-time work, both during the daytime and nighttime, had a similar relationship with poor sleep quality. Our findings also align with the study by Mehrdad et al. [9] of firefighters in Iran. They revealed a relationship between overtime work and poor sleep quality, which is also consistent with the study in the United States [16]. This may be due to the shift work patterns of firefighters in Bangkok that provide a 24-hour rest period before starting their next shift. Overtime work performed during this resting period can result in insufficient rest time and disrupt the balance of the sleep-wake cycle. Night shift work with daytime sleep in the presence of bright light, can also affect circadian rhythms and suppress melatonin secretion, leading to poor long-term sleep quality [19].

Sleeping areas with loud noises and uncomfortable bed facilities were associated with poor sleep quality. The study examining firefighters' performance in difficult environments, found that poor sleep quality was affected by environmental and sleep hygiene factors [20]. Similarly, a study of nurses in Thailand revealed a significant association between noisy and uncomfortable sleeping quarters and poor sleep quality [21]. This may be attributed to the fact that a quiet and comfortable sleeping environment is crucial in promoting sleep health, reducing sleep disturbances and nighttime awakenings, and facilitating an easier transition into rapid eye movement sleep, ultimately leading to better sleep quality. In addition, the presence of loud noises in sleeping quarters is a disruptive factor, causing frequent awakenings and hindering the ability to enter normal sleep cycles [22].

The strength of this research lies in its focus on firefighters who were at risk of experiencing poor sleep quality, which is a limited area of study in Thailand. Our study also demonstrated the factors related to sleep quality. Moreover, the research instrument utilized in this study was a reliable and valid Thai version of the PSQI, with a Cronbach's alpha coefficient of 0.84 [12]. In addition, the study achieved a relatively high response rate of 78.7%, indicating a sufficient sample size and ensuring the credibility of the study results.

The limitation of this study was its cross-sectional study design, which identified the relationship between various factors and sleep quality but could not establish a causal relationship. Moreover, the contradictory and statistically insignificant findings from our study might have occurred by chance or be a reflection of the healthy worker effect. Some questions in the questionnaire that addressed the various factors may have been overly broad and lacked specificity, as they were not structured using a formal questionnaire. For instance, questions related to family relationships might elicit arbitrary responses. In addition, the inquiries about extra part-time jobs did not delve into the specific nature of the work performed, and the questions concerning shifts only distinguished between discontinuous and continuous shifts, possibly lacking the necessary detail to thoroughly examine their relationship with sleep quality. The use of a self-reported sleep quality assessment may introduce potential misunderstanding in some questions and social preference bias. There could also be recall bias among respondents.

This study provided valuable data for prioritizing and proposing various occupational health measures that address factors impacting sleep quality. Additional studies are recommended using a cohort study design to explore causal relationships. For future studies to apply at the national level, they should also be expanded to include samples from different provinces, thus addressing variations in work context, job characteristics, or workplace environments that impact sleep quality. Finally, more attention should be given to the impact on sleep quality of the various factors related to dangerous and physically demanding jobs. Policymakers and all stakeholders should consider sleep quality a priority when addressing preventive measures and health promotion campaigns among the working population.

In conclusion, this study found that poor sleep quality was associated with various factors, including personal family relationships, work-related issues, and environmental factors. These factors included working extra part-time jobs, noisy sleeping areas, and inadequate bedding. Therefore, organizations should promote policies that improve sleep quality by including screening for sleep health, promoting activities that raise awareness of sleep health and good sleep hygiene, and providing adequate bedding in the sleeping accommodations of all fire stations. These measures aim to ensure that personnel have good sleep quality in the future.

NOTES

Supplemental Materials

Supplemental material is available at https://doi.org/10.3961/jpmph.23.305.

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REFERENCES

1. Regional Office for Europe of the World Health Organization. WHO technical meeting on sleep and health; 2004 [cited 2022 Sep 9]. Available from: https://www.ilo.org/wcmsp5/groups/public/---ed_protect/---protrav/---safework/documents/publication/wcms_118388.pdf

2. Mollayeva T, Thurairajah P, Burton K, Mollayeva S, Shapiro CM, Colantonio A. The Pittsburgh sleep quality index as a screening tool for sleep dysfunction in clinical and non-clinical samples: a systematic review and meta-analysis. Sleep Med Rev 2016;25:52-73. https://doi.org/10.1016/j.smrv.2015.01.009

3. Nelson KL, Davis JE, Corbett CF. Sleep quality: an evolutionary concept analysis. Nurs Forum 2022;57(1):144-151. https://doi.

4. International Labour Organization. Quality sleep [cited 2022 Sep 9]. Available from: https://www.ilo.org/global/topics/safety-and-health-at-work/areasofwork/WCMS_118392/lang--en/index.htm?fbclid=IwAR0kAo9i2KHd2YKmW16F25qwLaR-9i38iM4nfpz59SFbbM26ZyHudQ4x0Vc

5. International Association of Fire Chiefs. Effects of sleep deprivation on fire fighters and EMS responders: final report; 2007 [cited 2022 Sep 10]. Available from: https://www.iafc.org/docs/default-source/1safehealthshs/progssleep_sleepdeprivationreport.pdf?sfvrsn=f9e4da0d_2

6. Khoshakhlagh AH, Al Sulaie S, Yazdanirad S, Orr RM, Dehdarirad H, Milajerdi A. Global prevalence and associated factors of sleep disorders and poor sleep quality among firefighters: a systematic review and meta-analysis. Heliyon 2023;9(2):e13250. https://doi.org/10.1016/j.heliyon.2023.e13250

7. Khumtong C, Taneepanichskul N. Posttraumatic stress disorder and sleep quality among urban firefighters in Thailand. Nat Sci Sleep 2019;11:123-130. https://doi.org/10.2147/NSS.S207764

8. Krejcie RV, Morgan DW. Determining sample size for research activities. Educ Psychol Meas 1970;30(3):607-610. https://doi.org/10.1177/001316447003000308

9. Mehrdad R, Haghighi KS, Esfahani AH. Sleep quality of professional firefighters. Int J Prev Med 2013;4(9):1095-1100.

10. Lim M, Lee S, Seo K, Oh HJ, Shin JS, Kim SK, et al. Psychosocial factors affecting sleep quality of pre-employed firefighters: a cross-sectional study. Ann Occup Environ Med 2020;32:e12. https://doi.org/10.35371/aoem.2020.32.e12

11. Buysse DJ, Reynolds CF 3rd, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh sleep quality index: a new instrument for psychiatric practice and research. Psychiatry Res 1989;28(2):193-213. https://doi.org/10.1016/0165-1781(89)90047-4

12. Sitasuwan T, Bussaratid S, Ruttanaumpawan P, Chotinaiwattarakul W. Reliability and validity of the Thai version of the Pittsburgh sleep quality index. J Med Assoc Thai 2014;97(Suppl 3): S57-S67.

13. Huang RS, Chen YC, Tsai SY, Huang YE, Guo YL. Incomplete off-duty work hours and sleep quality among firefighters: a cross-sectional study, Taiwan. Int Arch Occup Environ Health 2023; 96(2):247-257. https://doi.org/10.1007/s00420-022-01918-9

14. Lim DK, Baek KO, Chung IS, Lee MY. Factors related to sleep disorders among male firefighters. Ann Occup Environ Med 2014;26:11. https://doi.org/10.1186/2052-4374-26-11

15. Savall A, Marcoux P, Charles R, Trombert B, Roche F, Berger M.

org/10.1111/nuf.12659

Sleep quality and sleep disturbances among volunteer and professional French firefighters: FIRESLEEP study. Sleep Med 2021;80:228-235. https://doi.org/10.1016/j.sleep.2021.01.041

16. Billings J, Focht W. Firefighter shift schedules affect sleep quality. J Occup Environ Med 2016;58(3):294-298. https://doi.org/10.1097/JOM.0000000000000624

17. Watkins SL, Shannon MA, Hurtado DA, Shea SA, Bowles NP. Interactions between home, work, and sleep among firefighters. Am J Ind Med 2021;64(2):137-148. https://doi.org/10.1002/ajim.23194

18. Troxel WM, Robles TF, Hall M, Buysse DJ. Marital quality and the marital bed: examining the covariation between relationship quality and sleep. Sleep Med Rev 2007;11(5):389-404. https://doi.org/10.1016/j.smrv.2007.05.002

19. Chokroverty S. Sleep disorders medicine: basic science, technical considerations and clinical aspects. 4th ed. New York: Springer; 2017, p. 1-1269.

20. Vincent GE, Aisbett B, Wolkow A, Jay SM, Ridgers ND, Ferguson SA. Sleep in wildland firefighters: what do we know and why does it matter? Int J Wildland Fire 2018;27(2):73-84. https://doi.org/10.1071/WF17109

21. Tupsangsee J, Jiamjarasrangsi W, Tangwongchai S. Quality of sleep among intensive care unit nurses in Thailand. Chulalongkorn Med J 2008;52(6):7 (Thai).

22. Liu J, Ghastine L, Um P, Rovit E, Wu T. Environmental exposures and sleep outcomes: a review of evidence, potential mechanisms, and implications. Environ Res 2021;196:110406. https://doi.org/10.1016/j.envres.2020.110406