

Job Stress and Sleep Disturbances Among Career Firefighters in Northern California

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Object: This study examined the association between job stress and sleep disturbance among career firefighters. **Methods:** A cross-sectional survey study was conducted with 154 career firefighters working in Northern California, US job stress was measured using the short form of the Effort-Reward Imbalance questionnaire and sleep was measured with the Patient-Reported Outcomes Measurement Information System Sleep Disturbance. **Results:** Approximately 75% experienced sleep disturbance. For firefighters' job stress, high effort (odds ratio [OR] = 3.68; 95% confidence interval [CI]: 1.25–10.80), high effort-reward ratio (OR = 3.55; 95% CI: 1.23–10.23), and high overcommitment (OR = 9.09; 95% CI: 2.30–35.85) were significantly associated with increased likelihood of sleep disturbance, after adjustment for other factors. **Conclusions:** Job stress significantly affected firefighters' sleep health, suggesting the need to design effective health promotion interventions to reduce job stress and improve sleep quality for these public service workers.

Keywords: job stress, sleep disturbance, firefighters

LEARNING OUTCOMES

Upon completion of reading this article, the readers will be able to

- describe the relationship between job stress and sleep disturbance among career firefighters.
- explain the importance of detecting and reducing job stress to improve sleep quality for these public service workers.

Sleep problems are associated with various health-related outcomes. Previous epidemiological studies have shown that sleep problems can have adverse effects on physical health including cardiovascular disease and diabetes as well as mental health including depression and anxiety,^{1–4} which may lead to reduce the quality of life. Firefighters are vulnerable to sleep problems due to their work shift schedule (24-/48-hour shift), the unpredictable nature of work, and

hazardous conditions on the job.^{5–9} Recent several studies in different countries such as the United States (US), Brazil, Iran, Korea, France, and Taiwan have reported that sleep problems are highly prevalent in firefighters.^{5,8–13} For instance, previous research on sleep disorders among US firefighters ($N = 6933$) reported that 37.2% of participating firefighters had at least one sleep disorder such as obstructive sleep apnea, insomnia, shift work disorder, and restless legs syndrome.¹ In addition, recent cross-sectional studies reported that more than 70% of firefighters had poor sleep quality^{8,13} and their shift schedules and off-duty work have increased the risk of poor sleep quality.^{7,8,13} Sleep problems among firefighters negatively influence not only their physical health status but also their safety outcomes including occupational accidents and injuries,^{1,14} which should be considered a critical occupational health concern.

Firefighting is one of the most both physically and psychosocially demanding occupations. Firefighters are routinely exposed to dangerous and stressful work environments; it involves multiple physical hazards including loud noise, high temperatures, and smoke with toxic fumes and particles, as well as shift work and unpredictable events.^{15–20} These working conditions put firefighters at high risk for occupational stress, which can negatively impact their health outcomes,^{21,22} including cardiovascular diseases,²³ musculoskeletal injury,²⁴ respiratory illness,²⁵ hearing loss,²⁶ tinnitus,²⁷ mental health,²⁸ and cancer.^{15,29} Especially, job stress in several occupational studies has been measured by the Effort-Reward Imbalance (ERI), which is widely used^{30,31} and validated for assessing job stress among firefighters.³² The ERI model consists of effort, reward, and overcommitment, and in this model, job stress is defined as an imbalance between high effort spent and low rewards received at work.^{30,31} Previous studies have shown that high job stress is associated with poor sleep quality.^{33–35} A recent meta-analysis demonstrated relationship between insomnia and higher levels of job stress with effort-reward imbalance, high demand, and heavy workload, as well as low social support.³⁶ Particularly, in a study of firefighters in Brazil, researchers suggest that psychological and physically stressful nature of firefighting may be related to the high prevalence of sleep disturbance.⁵ Although firefighters are at high risk of sleep disturbances and job stress, little is known about the link between job stress and sleep problems among firefighters. Therefore, the purpose of the present study was to examine the association between job stress and sleep disturbance among career firefighters, controlling for demographic and work-related characteristics.

METHODS

Study Design and Participants

This cross-sectional web-based survey study was conducted with firefighters in Northern California. Study participants were recruited through flyers with study information at fire stations and fire department email announcements. The study data were collected through the internet from April to September in 2016. A total of 180 firefighters responded to participate in the study. Fourteen percent (26/180) of the initial respondents were excluded from the study because of the incompleteness of their responses to the online survey. Thus, 154 firefighters were included in the analysis in the present study. This study was approved and monitored by the University of California, San Francisco Committee on Human Subjects. Participation

From the School of Nursing, University of California, San Francisco (UCSF), San Francisco, California (D.L.C., R.O., O.H.); National Clinician Scholars Program, Institute for Health Policy Studies, University of California San Francisco, San Francisco, California (R.O.); Lamson Dugan and Murray LLC, Des Moines, Iowa; and Expert Witness Consultancy, Madison, Wisconsin (R.O.)

Ethical Considerations and Disclosures: All study procedures were approved by the Committee on Human Research at the University of California, San Francisco. Online informed consent was obtained from firefighter participants before completing the survey.

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was voluntary and online informed consent was obtained from the participants before completing the survey. All participants received a \$10 gift card for their contribution to the study.

Study Measures and Variables

Demographics and Work-Related Characteristics

Age, race/ethnicity, sex, job position, years in the fire service, and shift (24-hour shift, 48-hour shift, and other) were measured. Race/ethnicity was categorized as Asian/Pacific Islander, African American or Black, Caucasian or White, or Hispanic or Latino/Latina.

Job Stress

Job stress was measured using the short version of the Effort-Reward Imbalance (S-ERI) questionnaire. The S-ERI is a validated and widely used measure of job stress³¹ and tested with firefighters.³² The S-ERI instrument consists of 16 items representing the following three subscales: (1) effort (3 items); (2) reward (7 items—two for “esteem,” two for “job security,” and three for “job promotion”), and (3) overcommitment (6 items). All items were scored on a 4-point Likert scale (1 = strongly disagree, 4 = strongly agree with statements).³¹ All scale scores were determined by summing up values for each item of each scale with appropriate recoding and higher scores reflect higher effort, reward, and overcommitment, respectively.

In the ERI model, job stress is defined as imbalance between high efforts (ie, working overtime) and low rewards (ie, fewer salary, esteem, job security, and promotions) at work. The effort-reward ratio was calculated from two subscales; effort and reward, dividing effort by reward multiplied by the ratio of the number of items in two scales (3 items in effort/7 items in reward) to correct for the item number difference in the two scales.³¹

Sleep Disturbance

Sleep disturbance was measured with the six-item Patient-Reported Outcomes Measurement Information System (PROMIS) Short-Form Sleep Disturbance.³⁷ The PROMIS sleep disturbance tool is designed to assess perceptions of sleep quality, sleep depth, and restoration associated with sleep over the past 7-day period. This sleep disturbance instrument is a self-report and includes perceived difficulties and concerns with getting to sleep or staying asleep, as well as perceptions of the adequacy of and satisfaction with sleep. Item statements include the following: “My sleep quality was...” (quality sleep); “My sleep was refreshing” (refreshing); “I had a problem with my sleep” (problem with sleep); “I had difficulty falling asleep” (difficulty falling asleep); “My sleep was restless” (restless); and “I tried hard to get to sleep” (Tried hard to get to sleep). Responses are measured on a five-point scale from “very poor” (1) to “very good” (5) for the sleep quality and from “not at all” (1) to “very much” (5) for remaining items. Two positive statements of all items were reverse coded and then the total raw score was calculated by summing up values of each item. The total raw score was rescaled into the standardized *T* score, using the PROMIS score conversion table.³⁸ For the PROMIS *T* score, calibration testing was performed on a large sample of the general population and a *T* score of 50 is the average for the US general population with a standard deviation (SD) of 10.³⁷ A higher PROMIS *T* score represents greater sleep disturbances. In this study, firefighters reporting PROMIS sleep disturbance *T* score more than 50 were considered as having sleep disturbance.^{37–40}

Statistical Analysis

Statistical analysis was conducted using IBM SPSS Statistics, version 28.0. Descriptive statistics were analyzed for study variables from the survey, using means and standard deviations for continuous variables and frequencies and percentages for categorical variables. Job stress (S-ERI) and sleep disturbance (PROMIS) were assessed

through multiple items that should intercorrelate. These items of each scale were checked for internal consistency reliability using Cronbach α coefficients. In our sample, all Cronbach α coefficients for S-ERI subscales (effort = 0.77, reward = 0.73, overcommitment = 0.84) and PROMIS (= 0.80) were higher than 0.70, indicating acceptable internal consistency.⁴¹

Bivariate analysis was performed to examine differences in sleep disturbance, using χ^2 tests and *t* tests for categorical variables and continuous variables, respectively. After bivariate analysis, multivariable logistic regression analysis was conducted to examine the relationships of job stress and sleep disturbance. Because age and years of fire services were highly correlated ($r = 0.85$, $P < 0.001$), only years of fire services was included in the multivariable models. Sex was also excluded from the analysis because only one female firefighter in the entire sample responded this survey. Of job stress, ERI subscales (effort, reward, and overcommitment) and effort-reward ratio were separately chosen as the indicator of the participant’s sleep disturbance in each multivariable model. The odds ratios (ORs) and 95% confidence intervals (CIs) were calculated to estimate the independent contribution of job stress on firefighters’ sleep disturbance, along with a corresponding *P* value. The level of statistical significance was set at a *P* value of 0.05.

RESULTS

Characteristics of the Study Participants

The summary of demographics and work-rated characteristics of the study participants is presented in Table 1. Participants were predominantly middle-aged (mean = 43.5 years, SD = 10.2) Caucasian or White (77.9%) males (99.4%). The most commonly reported job positions were fire captain (25.7%), followed by firefighter engineer (23.0%), chief officer (19.1%), firefighter paramedic (11.2%), firefighter (10.5%), and firefighter lieutenant (5.3%). Most firefighters worked 48-hour shift (61.2%) and worked in fire service for an average age of 18.38 years (SD = 9.7).

The participants’ mean scores for S-ERI subscales of job stress were 9.29 for effort, 21.07 for reward, 13.90 for overcommitment, and 1.07 for effort-reward ratio (Table 2).

TABLE 1. Demographics and Work-Related Characteristics of the Study Participants (*N* = 154)^a

Characteristics	Mean \pm SD or <i>n</i> (%)
Age, yr	43.53 \pm 10.23
Sex	
Male	153 (99.4)
Female	1 (0.6)
Race/ethnicity	
Asian/Pacific Islanders	10 (6.5)
African American or Black	2 (1.3)
Caucasian or White	120 (77.9)
Hispanic or Latino/a	22 (14.3)
Job position	
Firefighter	16 (10.5)
Firefighter engineer	35 (23.0)
Firefighter paramedic	17 (11.2)
Firefighter lieutenant	8 (5.3)
Fire captain	39 (25.7)
Chief officer	29 (19.1)
Other	8 (5.3)
Years in the fire service	18.38 \pm 9.67
Shift	
24-hr	30 (19.7)
48-hr	93 (61.2)
Other	29 (19.1)

^a Numbers for characteristics do not total the same number because of missing data.

Sleep Disturbance

Table 3 presents sleep disturbance of the study participants. The mean sleep disturbance item scores were between 2.21 and 2.92, ranging from 1 to 5. The mean standardized PROMIS Sleep Disturbance *T* score of the participants was 53.98, much higher than that of the US general population (mean = 50); approximately 75% of the participants experienced sleep disturbance.

Comparison of Characteristics Between Firefighters With and Without Sleep Disturbance

Table 4 presents the comparison of characteristics of participants with and without sleep disturbance. In the bivariate analyses, there were no significant differences in demographic and work characteristics between the two groups (firefighters with and without sleep disturbance). For job stress, firefighters with sleep disturbance reported higher effort (9.51 vs 8.62, $P = 0.012$), higher overcommitment (14.32 vs 12.64, $P = 0.003$), and higher effort-reward ratio (1.10 vs 0.98, $P = 0.066$), compared with those without sleep disturbance.

Association of Job Stress With Sleep Disturbance

Table 5 presents multivariable associations of job stress with sleep disturbance in firefighters. Of job stress, high effort (OR = 3.68; 95% CI: 1.25–10.80), high effort-reward ratio (OR = 3.55; 95% CI: 1.23–10.23), and high overcommitment (OR = 9.09; 95% CI: 2.30–35.85) were significantly associated with increased likelihood of sleep disturbance, after adjustment for other factors.

DISCUSSION

The findings of this study indicate that sleep disturbances are common among firefighters, a population of workers at risk for multiple occupational health problems, and the extent of sleep problems among firefighters is greater than that of general population. In addition, aspects of firefighters' work-related stress levels were associated with sleep disturbances after adjustment for age/years of service, job role, and shift worked.

The link between job stress and sleep quality has been previously demonstrated among firefighters outside the US. In a study of 705 male firefighters in Korea, researchers found that those in the highest tertile of reported work-related stress had the highest level of overall sleep dysfunction,³⁵ a finding which closely aligns with our study. However, the researchers used the Korean Occupational Stress Scale, which measures elements of job-related stress but not the constructs of effort-reward ratio or overcommitment, which demonstrated the strongest valence to sleep disturbance in our sample. The stress-sleep correlation has also been explored in multiple contexts and for diverse occupations. In a study of long-haul truck drivers in the US, researchers investigated the links between working conditions, job-related stress, sleep, poor health outcomes, and various health-related behaviors.⁴² While their focus was on linking stress and sleep to other behaviors like exercise, caffeine, and alcohol intake, researchers did find that both moderate to chronic stress and frequent reported poor sleep

TABLE 3. Sleep Disturbance of the Study Participant ($N = 154$)

Characteristics	Mean \pm SD or n (%)
Sleep disturbance	53.98 \pm 6.37
Normal sleep	39 (25.3)
Sleep disturbance ^a	115 (74.7)
Sleep disturbance items	
Quality sleep ^b (1–5)	2.92 \pm 0.88
Refreshing ^b (1–5)	2.77 \pm 0.91
Problem with sleep (1–5)	2.81 \pm 1.02
Difficulty falling asleep (1–5)	2.21 \pm 1.07
Restless (1–5)	2.88 \pm 1.17
Tried hard to get to sleep (1–5)	2.38 \pm 1.26

^a Sleep disturbance: *T* score >50.

^b Positive statement items.

were associated with increased likelihood of a mental health diagnosis.⁴² Although our study did not explore these additional health behaviors, there are important demographic similarities between the two worker populations, and it seems likely that many of the consequences of these overlapping concerns would likely align between truck drivers and firefighters. In a study of community health workers in China, researchers also used the ERI scale to measure the impact of job-related stress on sleep.³³ Incorporating findings from both doctors and nurses in their sample, the researchers reported that the constructs of high effort, high ERI ratio, and overcommitment were all associated with an increased likelihood of sleep disturbance as detected by the Pittsburgh Sleep Quality Index.³³

Sleep difficulties have been linked to psychological and health consequences in firefighters¹ and in the broader population.^{2,3} One way that researchers have looked at the ways sleep can directly or indirectly impact firefighters' ability to continue doing their challenging and essential work is by measuring burnout,²¹ a phenomenon linked to intention to quit.⁴³ Although our study did not investigate the construct of burnout directly, this literature is relevant to the interpretation of our findings and helps develop understanding of the implications of unmanaged stress. In recent work describing findings from a large sample of firefighters in North America, researchers explored the links between sleep, mental health conditions, and burnout.⁴⁴ Their logistic regression analyses pointed to the correlation between emotional exhaustion and insomnia in particular, which also were both tied to mental health diagnoses.⁴⁴ The connection between job stress and burnout has also been demonstrated among firefighters in Brazil.⁴⁵ Researchers there found that experiences of high strain (as measured by the Job Stress Scale) were particularly associated with increased odds of burnout and the construct of emotional exhaustion most strongly.⁴⁵ This connection is supported by our finding that firefighters reporting the highest job stress scores related to the "effort" construct had 3.7 times the odds of sleep disturbance as those in the lowest tertile. Linking our findings to other work surrounding firefighter burnout points to the importance of addressing both job stress and sleep disturbance because both of these issues have implications for organizations' capacity to retain their workforce and perform essential functions in society.

In an exploration of the intersections between job stress, sleep, and burnout among Chinese nurses, researchers found that sleep seemed to be an important mediator between job stress and burnout.⁴⁶ To measure stress, researchers used the Perceived Stress Scale, which captures frequency of stress-causing events broadly and then assigns a global score. For the nurses in their sample, high levels of stress not only led directly to emotional exhaustion (a component of burnout) but also impaired sleep, which was a mediator on the path to burnout as well.⁴⁶ This finding in another population of workers with high rates of job-related stress points to an important implication for beginning to develop a clearer understanding of how these phenomena

TABLE 2. Job Stress of the Study Participants ($N = 154$)

Characteristics	Mean \pm SD
Job Stress	
Effort (3–12)	9.29 \pm 1.94
Reward (7–28)	21.07 \pm 3.39
Esteem (2–8)	6.06 \pm 1.28
Job security (2–8)	6.47 \pm 1.19
Job promotion (3–12)	8.53 \pm 1.75
Overcommitment (6–24)	13.90 \pm 3.81
Effort-reward ratio	1.07 \pm 0.36

TABLE 4. Comparison of Characteristics Between Firefighters With and Without Sleep Disturbance

	With Sleep Disturbance (n = 115)	Without Sleep Disturbance (n = 39)	P
	Mean ± SD or n (%)	Mean ± SD or n (%)	
Age	43.05 ± 9.80	44.95 ± 11.43	0.319
Sex (male)	115 (100.0)	38 (97.4)	0.253
Race (White)	90 (78.3)	30 (76.9)	0.827
Job position			
Firefighter	12 (10.6)	4 (10.3)	0.860
Firefighter engineer	26 (23.0)	9 (23.1)	
Firefighter paramedic	12 (10.6)	5 (12.8)	
Firefighter lieutenant	5 (4.4)	3 (7.7)	
Fire captain	32 (28.3)	7 (17.9)	0.713
Chief officer	21 (18.6)	8 (20.5)	
Other	5 (4.4)	3 (7.7)	
Years in working services	18.21 ± 9.77	18.87 ± 9.49	
Shift			
24-hr	19 (16.8)	11 (28.2)	0.290
48-hr	71 (62.8)	22 (56.4)	
Other	23 (20.4)	6 (15.4)	
Job stress			
Effort	9.51 ± 1.91	8.62 ± 1.87	0.012
Reward	21.08 ± 3.57	21.05 ± 2.80	0.966
Esteem	6.05 ± 1.38	6.10 ± 0.94	0.833
Job security	6.46 ± 1.23	6.51 ± 1.10	0.815
Job promotion	8.57 ± 1.81	8.43 ± 1.55	0.691
Overcommitment	14.32 ± 4.07	12.64 ± 2.57	0.003
Effort-reward ratio	1.10 ± 0.37	0.98 ± 0.30	0.066

impact firefighters and why an intervention addressing poor sleep can help prevent burnout. Future research in firefighters could similarly examine the implications of the findings presented here to develop better understanding of the cost of continued job stress and sleep disruption for the workforce.

Other research has examined the impact of more severe psychological disturbances on sleep in firefighters. In a study of firefighters who have experienced traumatic events on the job, researchers investigated psychological factors that are likely to be associated with sleep disturbances, finding that certain manifestations of posttraumatic stress disorder like increased anger were more likely to cause disrupted sleep.⁴⁷ For these trauma-exposed firefighters, traumatic experiences were filtered through their individual characteristics, demonstrating that such events did not impact all workers uniformly, necessitating an individualized approach to treatment and management of resulting mental health challenges. The findings we present in this study suggest a similar approach, as the ERI constructs of high effort, high effort-reward ratio, and high overcommitment were the areas most associated with sleep disturbance in the sample. In this way, the broad conceptualization of job-related stress can be refined to focus on those elements most likely to lead to health consequences, both in terms of helping workers cope with the demands of the job and in advocating for work redesign that mitigates these factors. This study leverages the unique approach of the ERI scale to capture what might be causing the most distress in the work environment.

As some of the authors of the ERI measurement tool describe, the theoretical foundation of their tool “is rooted in contracts of reciprocity of cost and gain.”³⁰ By this, the authors argue that there is a way to structure the expectations, rewards, and general culture of a workplace to enhance the balance of these experiences for workers and prevent exposure to the consequences of excessive cost without

appropriate compensation or recognition. Recent work among firefighters in China has explored the role of “colleagueship” as a moderator between burnout and depressive symptoms.⁴⁸ This construct captures unique attributes of workplace connections and expectations, helping describe how workers’ commitment to each other takes on both emotional and obligatory dimensions. While enhancing workers’ connections to their teams can be valuable, these results also point to the ways that workers in public service professions like firefighting are prone to overcommitment, as they are asked to contribute more than what is described in their official job roles in the interest of supporting their colleagues and the organization’s mission. Correction of an imbalance needs to closely interrogate how domains of effort and rewards are defined in a given workplace and how well the expectations are communicated to workers.

Limitations

The study has several limitations. First, because the data collected are cross-sectional, our ability to demonstrate causality between variables is limited, leading to questions surrounding the onset of the phenomena of work-related stress and sleep disturbance. Second, because of the self-reported nature of both S-ERI and PROMIS sleep disturbance variables, we cannot rule out recall or reporting bias. In addition, the sample selected from Northern California in the US was limited geographically and was not diverse with respect to sex or race/ethnicity; thus, this may impact some of the generalizability of the previously mentioned findings. However, the US fire service is a predominately White male-dominated occupation.

CONCLUSIONS

This study of firefighters in the US describes a clear link between sleep disturbance and job-related stress, particularly high-effort and overcommitment. Our findings add to the existing literature describing the high psychosocial burden firefighters face at work, in addition to the physical risks, and the growing evidence documenting the impact of these stressors on their health. As those engaged in health promotion efforts develop plans to address these concerns, it will be important to consider how to enhance resilience among firefighters and critically engage with policy questions that structure the work environment.

TABLE 5. Multivariable Association of Job Stress With Sleep Disturbance

Job Stress	Sleep Disturbance	P
	OR (95% CI) ^a	
Effort		
Low tertile	1	
Medium tertile	1.27 (0.47–3.43)	0.632
High tertile	3.68 (1.25–10.80)	0.018
Reward		
Low tertile	1	
Medium tertile	0.90 (0.36–2.22)	0.810
High tertile	0.68 (0.25–1.86)	0.456
Effort-reward ratio		
Low tertile	1	
Medium tertile	1.75 (0.67–4.60)	0.256
High tertile	3.55 (1.23–10.23)	0.019
Overcommitment		
Low tertile	1	
Medium tertile	1.24 (0.48–3.19)	0.652
High tertile	9.09 (2.30–35.85)	0.002

^a Adjusted for years of services, job position, and shift.
CI, confidence interval; OR, odds ratio.

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1. Barger LK, Rajaratnam SM, Wang W, et al. Common sleep disorders increase risk of motor vehicle crashes and adverse health outcomes in firefighters. *J Clin Sleep Med* 2015;11:233–240.
2. Kwok CS, Kontopantelis E, Kuligowski G, et al. Self-reported sleep duration and quality and cardiovascular disease and mortality: a dose-response meta-analysis. *J Am Heart Assoc* 2018;7:e008552.
3. Khalil M, Power N, Graham E, Deschenes SS, Schmitz N. The association between sleep and diabetes outcomes—a systematic review. *Diabetes Res Clin Pract* 2020;161:108035.
4. Alvaro PK, Roberts RM, Harris JK. A systematic review assessing bidirectional relationship between sleep disturbances, anxiety, and depression. *Sleep* 2013;36:1059–1068.
5. Vargas de Barros V, Martins LF, Saitz R, Bastos RR, Ronzani TM. Mental health conditions, individual and job characteristics and sleep disturbances among firefighters. *J Health Psychol* 2013;18:350–358.
6. Stout JW, Beidel DC, Brush D, Bowers C. Sleep disturbance and cognitive functioning among firefighters. *J Health Psychol* 2021;26:2248–2259.
7. Jeong KS, Ahn YS, Jang TW, et al. Sleep assessment during shift work in Korean firefighters: a cross-sectional study. *Saf Health Work* 2019;10:254–259.
8. Billings J, Focht W. Firefighter shift schedules affect sleep quality. *J Occup Environ Med* 2016;58:294–298.
9. Lim DK, Baek KO, Chung IS, Lee MY. Factors related to sleep disorders among male firefighters. *Ann Occup Environ Med* 2014;26:11.
10. Carey MG, Al-Zaiti SS, Dean GE, Sessanna L, Finnell DS. Sleep problems, depression, substance use, social bonding, and quality of life in professional firefighters. *J Occup Environ Med* 2011;53:928–933.
11. Mehrdad R, Haghighi KS, Esfahani AH. Sleep quality of professional firefighters. *Int J Prev Med* 2013;4:1095–1100.
12. Savall A, Marcoux P, Charles R, Trombert B, Roche F, Berger M. Sleep quality and sleep disturbances among volunteer and professional French firefighters: FIRESLEEP study. *Sleep Med* 2021;80:228–235.
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* 2022;96:247–257.
14. Elliot DL, Kuehl KS. *Effects of Sleep Deprivation on Fire Fighters and EMS Responders*. Portland, OR: International Association of Fire Chiefs; 2007.
15. Campbell R, Evarts B. United States firefighter injuries in 2020. 2021 Available at: <https://www.nfpa.org/-/media/Files/News-and-Research/Fire-statistics-and-reports/Emergency-responders/osf/injuries.pdf?2>. Accessed November 11, 2022.
16. Clark WW, Bohl CD. Hearing levels of firefighters: risk of occupational noise-induced hearing loss assessed by cross-sectional and longitudinal data. *Ear Hear* 2005;26:327–340.
17. Choi B, Dobson M, Schnall P, Garcia-Rivas J. 24-Hour work shifts, sedentary work, and obesity in male firefighters. *Am J Ind Med* 2016;59:486–500.
18. Oliveira M, Slezakova K, Fernandes A, et al. Occupational exposure of firefighters to polycyclic aromatic hydrocarbons in non-fire work environments. *Sci Total Environ* 2017;592:277–287.
19. Adetona O, Zhang JJ, Hall DB, Wang JS, Vena JE, Naeher LP. Occupational exposure to woodsmoke and oxidative stress in wildland firefighters. *Sci Total Environ* 2013;449:269–275.
20. Baxter CS, Hoffman JD, Knipp MJ, Reponen T, Haynes EN. Exposure of firefighters to particulates and polycyclic aromatic hydrocarbons. *J Occup Environ Hyg* 2014;11:D85–D91.
21. Igboanugo S, Bigelow PL, Mielke JG. Health outcomes of psychosocial stress within firefighters: a systematic review of the research landscape. *J Occup Health* 2021;63:e12219.
22. Niedhammer I, Bertrais S, Witt K. Psychosocial work exposures and health outcomes: a meta-review of 72 literature reviews with meta-analysis. *Scand J Work Environ Health* 2021;47:489–508.
23. Soteriades ES, Smith DL, Tsismenakis AJ, Baur DM, Kales SN. Cardiovascular disease in US firefighters: a systematic review. *Cardiol Rev* 2011;19:202–215.

24. Kim MG, Kim KS, Ryoo JH, Yoo SW. Relationship between occupational stress and work-related musculoskeletal disorders in Korean male firefighters. *Ann Occup Environ Med* 2013;25:9.
25. Ramos C, Minghelli B. Prevalence and factors associated with poor respiratory function among firefighters exposed to wildfire smoke. *Int J Environ Res Public Health* 2022;19.
26. Hong O, Chin DL, Samo DG. Hearing loss and use of hearing protection among career firefighters in the United States. *J Occup Environ Med* 2013;55:960–965.
27. Odes R, Chin DL, Li J, Hong O. Association of occupational stress with tinnitus among career firefighters in the United States. *J Occup Environ Med* 2022;65:e30–e35.
28. Serrano-Ibanez ER, Corras T, Del Prado M, Diz J, Varela C. Psychological variables associated with post-traumatic stress disorder in firefighters: a systematic review. *Trauma Violence Abuse* 2022;15248380221082944.
29. Jalilian H, Ziaei M, Weiderpass E, Rueegg CS, Khosravi Y, Kjaerheim K. Cancer incidence and mortality among firefighters. *Int J Cancer* 2019;145:2639–2646.
30. Siegrist J, Starke D, Chandola T, et al. The measurement of effort-reward imbalance at work: European comparisons. *Soc Sci Med* 2004;58:1483–1499.
31. Siegrist J, Wege N, Puhlhofer F, Wahrendorf M. A short generic measure of work stress in the era of globalization: effort-reward imbalance. *Int Arch Occup Environ Health* 2009;82:1005–1013.
32. Chin DL, Kyung M, Li J, Phelps S, Hong O. The short form effort-reward imbalance: measure of occupational stress for firefighters. *Am J Ind Med* 2022;65:492–499.
33. Deng X, Fang R, Cai Y. Evaluation of the correlation between effort-reward imbalance and sleep quality among community health workers. *BMC Health Serv Res* 2021;21:490.
34. Knudsen HK, Ducharme LJ, Roman PM. Job stress and poor sleep quality: data from an American sample of full-time workers. *Soc Sci Med* 2007;64:1997–2007.
35. Yook YS. Firefighters' occupational stress and its correlations with cardiorespiratory fitness, arterial stiffness, heart rate variability, and sleep quality. *PLoS One* 2019;14:e0226739.
36. Yang B, Wang Y, Cui F, et al. Association between insomnia and job stress: a meta-analysis. *Sleep Breath* 2018;22:1221–1231.
37. HealthMeasures. PROMIS® (Patient-Reported Outcomes Measurement Information System) 2016. Available at: <http://www.healthmeasures.net/explore-measurement-systems/promis>. Accessed November 29, 2022.
38. HealthMeasures. Sleep disturbance scoring manual: PROMIS, Version 1.0. 2021; Available at: https://staging.healthmeasures.net/images/PROMIS/manuals/PROMIS_Sleep_Disturbance_Scoring_Manual.pdf. Accessed November 29, 2022.
39. Jensen RE, King-Kallimanis BL, Sexton E, et al. Measurement properties of PROMIS Sleep Disturbance short forms in a large, ethnically diverse cancer cohort. *Psychological Test and Assessment Modeling*. 2016;58:353–370.
40. Dwi Tama T, Astutik E. Sleep disturbance and general health status in patients with chronic conditions. *KnE Life Sci* 2021;6:159–170.
41. Nunnally JC, Bernstein IH. *Psychometric Theory*. New York, NY: McGraw-Hill; 1994.
42. Hege A, Lemke MK, Apostolopoulos Y, Sonmez S. The impact of work organization, job stress, and sleep on the health behaviors and outcomes of U.S. long-haul truck drivers. *Health Educ Behav* 2019;46:626–636.
43. Madigan DJ, Kim LE. Towards an understanding of teacher attrition: a meta-analysis of burnout, job satisfaction, and teachers' intentions to quit. *Teach Teach Educ* 2021;105:103425.
44. Wolkow AP, Barger LK, O'Brien CS, et al. Associations between sleep disturbances, mental health outcomes and burnout in firefighters, and the mediating role of sleep during overnight work: a cross-sectional study. *J Sleep Res* 2019;28:e12869.
45. de Carvalho TGS, Araujo LF, Lima EP, et al. Burden and protection: heterogeneous effects of occupational and operational stressors on burnout dimensions among firefighters. *J Occup Environ Med* 2021;63:e899–e904.
46. Song Y, Yang F, Sznajder K, Yang X. Sleep quality as a mediator in the relationship between perceived stress and job burnout among Chinese nurses: a structural equation modeling analysis. *Front Psych* 2020;11:566196.
47. Griffith EL, Jin L, Contractor AA, Slavish DC, Vujanovic AA. Heterogeneity in patterns of posttraumatic stress disorder symptoms and sleep disturbances among firefighters: latent profile analyses. *J Psychiatr Res* 2022;153:64–72.
48. Cui L, Huang N, Bai Y, Fu M, Zia S, Guo J. The relationship between job burnout and depressive symptoms among Chinese firefighters: collegiality as a moderator. *J Occup Environ Med* 2022;64:659–664.