

Factors affecting health-related quality of life among firefighters during the COVID-19 pandemic: A single-center study

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SUMMARY During the coronavirus disease 2019 (COVID-19) outbreak, firefighters have been working in an environment that is both physically and mentally taxing. This study aimed to investigate factors affecting health-related quality of life (HRQOL) among firefighters in Japan during the COVID-19 pandemic. A total of 227 firefighters from a single firefighting organization were surveyed in June 2021, during the fourth infection spread period of COVID-19 in Japan. Regression analysis was performed to examine factors affecting HRQOL of firefighters measured with the SF-8. In the present study, factors affecting HRQOL among firefighters during the COVID-19 pandemic were lack of sleep, physical abnormalities due to infection control measures, exercise habits, living with family members, and history of suspected COVID-19 infection. The present findings may help develop support services for first responders, including firefighters during the COVID-19 pandemic.

Keywords COVID-19 pandemic, firefighters, health-related quality of life

1. Introduction

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), which causes the novel coronavirus disease 2019 (COVID-19), was first reported in Wuhan, China, in December 2019 (1). Shortly thereafter, the outbreak developed into a pandemic. As of September 2022, the total number of infected people in Japan is more than 20 million. A national lockdown introduced in Italy during the COVID-19 pandemic has had negative effects on mental health, anxiety, and sleep (2). In Japan, on April 7, 2020, the state of emergency was declared in seven prefectures, including Tokyo and Kanagawa; subsequently, from April 16 to May 31, 2020, the state of emergency was extended nationwide to prevent the spread of SARS-CoV-2. In October 2021, the state of emergency was declared for the fourth time in areas with high rates of infection spread. The state of emergency shortened restaurant operating hours and imposed a curfew and social distancing measures, including remote working, to help reduce the pressure on medical systems. During periods when the state of emergency was not

declared, the government continued to encourage social distancing and discouraged large indoor gatherings. Overall, the pandemic has affected lifestyle choices and socioeconomic conditions worldwide.

Since the outbreak, firefighters have been responding to emergency calls from confirmed and suspected COVID-19 patients and supporting treatment and transport activities. Fear of infection and the resulting anxiety increase the levels of emotional and physical strain that affect the ways in which duties are performed in the field. Additional concerns include worries about transmitting infection acquired at work to one's family or other cohabiting individuals. In South Florida, United States, the rate of infection among firefighters has been estimated at 8.9% (3), resulting in frequent leave of absence requests (4). Firefighters, as first responders, have a particularly high risk of contracting COVID-19; in addition, like their colleagues in the clinic, firefighters are susceptible to the psychological effects of the pandemic and require appropriate care and support (5). Early evidence from studies conducted in Germany has shown psychological effects of the pandemic on

frontline workers, including increased rates of anxiety and depression (6).

In Japan, the strain of the pandemic on doctors and nurses has received some public scrutiny, including discussions on the need for care and support. Meanwhile, the risks faced by firefighters and other emergency personnel have received little attention. Despite government guidance on infection control and health management among firefighters, leadership may only respond to individual cases. In addition, the evidence on health-related quality of life (HRQOL) among firefighters during the pandemic is scarce, making intervention design and implementation challenging.

The present study aimed to conduct a survey of firefighters working for a single organization to elucidate the impact of the pandemic on emergency responders' levels of HRQOL. We hypothesized that the factors listed in this study related to life, work, COVID-19, *etc.* would affect the HRQOL of firefighters during a COVID-19 pandemic. HRQOL was measured with the SF-8™ questionnaire (Japanese version), which is a shortened version of the SF-36 health survey, both of which have been previously used for HRQOL assessments (7). The SF-8 was used due to its brevity, helping make assessments straightforward.

2. Materials and Methods

2.1. Participants

The participants were firefighters who work for a firefighting team, rescue team, and ambulance services at a single front-line organization providing pre-hospital care. In the years studied, each team had 113, 24, and 92 placements, for a total of 229 people. This organization covers a population of approximately 310,000 people in the study area and receives approximately 13,000 emergency calls per year. During the COVID-19 pandemic, many of the participating firefighters were engaged in 24-hour workdays to account for the additional infection prevention and control protocols and equipment introduced since the start of the outbreak. In addition, the participants remained on duty during their shifts and responded to emergency calls.

This survey was conducted in mid-June 2021, in the middle of the fourth infection spread period of COVID-19 in Japan. During this period, lockdowns were introduced elsewhere in the world but not in Japan. However, some restrictions were introduced in the study area. In June 2021, the month in which the study was conducted, 160 COVID-19 patients (1 in June of the previous year) were reported for the month in the targeted city. The number of emergency calls in the city during the surveyed month was approximately 1,100 (previous year: approximately 990), of which 260 (previous year: approximately 200) were dispatched by the firefighting teams at the same time. The Fire and Disaster

Management Agency notified the fire department of the following points to keep in mind for the continuation of fire department operations in preparation for the spread of COVID-19: securing infection-prevention equipment and materials, thorough infection-prevention measures within the fire department, and quarantine for emergency personnel who were engaged in responding to infectious diseases.

This aims, objectives, and protocols of this study were presented to the fire department manager to obtain their consent for collaboration. The questionnaires were distributed through facility administrators and were filled out anonymously and individually before being sealed in submission envelopes and returned to the site administrators.

2.2. Survey

The participants' HRQOL was assessed with the SF-8™ Japanese version. The SF-8 consists of eight items: physical functioning (PF), role physical (RP), bodily pain (BP), general health (GH), vitality (VT), social functioning (SF), role emotional (RE), and mental health (MH), and reflects on health status over the past month. Each item is rated on a 5- or 6-point Likert scale; the scores are standardized, using 50 points as the national average score indicating normal health and functioning. Physical summary scores (PCS) and mental summary scores (MCS) were calculated by weighting the individual SF-8 item scores. For each factor, higher scores indicate better health. The Japanese version of the SF-8 is based on the 2017 nationwide survey of 3,286 Japanese residents and meets the standard criteria for content and construct validity (8,9). Cronbach's coefficient alpha was 0.841 in this study as well, confirming its reliability.

Data on the following demographic and clinical characteristics were collected: division affiliation, age, sex, living with family, sleep quality (lack of sleep), and exercise habits (1-2 times/week, 3-4 times/week, and 5-6 times/week). In addition, the participants were asked "yes" or "no" questions on their previous confirmed or suspected COVID-19 infection, vaccine uptake, Experience of transporting COVID-19 patients, and any physical abnormalities due to the infection control measures. Infection control measures here include wearing masks, face shields, gowns, and using disinfectant solutions.

2.3. Statistical analysis

The mean score for each SF-8 item was calculated and compared with the national standard value in Japan. Inter-group comparisons were performed using the Mann-Whitney *U* Test or Kruskal-Wallis test. The variables that were found to be significantly associated with each of the SF-8 items by this analysis were used

as independent variables, and regression analysis by the forced injection method was conducted with each of the SF-8 items as the dependent variables. In the regression analysis, variance inflation factor (VIF) was calculated to determine multicollinearity. The following variables were transformed into dummy variables (1, 0) and included in the model: living with a family member, lack of sleep, exercise habits, suspected COVID-19 infection status, experience of transporting COVID-19 patients, SARS-CoV-2 vaccination, and physical abnormalities due to infection control measures. In all statistical analyses, a significance level of $< 5\%$ was set. All analyses were performed in SPSS for windows (IBM Corp Armonk, NY, USA).

2.4. Ethics

The study was conducted in accordance with the principles of the Declaration of Helsinki and conducted with the approval of the Ethical Review Committee of Chubu University (Approval No.: 20200042). Written informed consent was obtained from the all participants of this study after they were provided a detailed explanation of the purpose of the study, methods involved, process of sample collection, and management of personal information.

3. Results

3.1. Participants

A total of 227 (99.1%) people were enrolled in this study. The response rate for each department was 90.2% for the

firefighting team, 91.7% for the rescue team, and 98.9% for ambulance services. Responses were obtained from a total of 222 (98.0%) respondents, with 215 (94%) valid responses. The sample was stratified by age, including 2 (1.0%), 79 (36.7%), 77 (35.8%), 49 (22.8%), 5 (2.3%), and 3 (1.4%) participants aged < 20 years, 20-29 years, 30-39 years, 40-49 years, 50-59 years, and > 60 years, respectively. This study included 208 (96.7%) males and 7 (3.3%) females.

3.2. Comparison with SF-8 standard values in Japan

The mean SF-8 item scores for the present study firefighting team, rescue team, and ambulance services, alongside the Japanese national standard values, are presented in Figure 1. The mean (standard deviation) bodily pain (48.85 ± 8.93 points) and social functioning (48.97 ± 7.42 points) scores in the present study were lower than the corresponding national average values (50.04 ± 8.17 points and 50.02 ± 7.17 points, respectively).

3.3. SF-8 item scores and participant characteristics

There was no difference in the SF-8 scores among affiliation, age, or sex groups (Table 1). Role physical ($p = 0.017$), general health ($p = 0.036$), and mental health ($p = 0.046$) scores were significantly higher in the participants that lived with family than in those that did not live with family. Physical functioning ($p = 0.005$), role physical ($p = 0.007$), bodily pain ($p = 0.024$), vitality ($p = 0.004$), social functioning ($p = 0.000$), role emotional ($p = 0.001$), mental health ($p =$

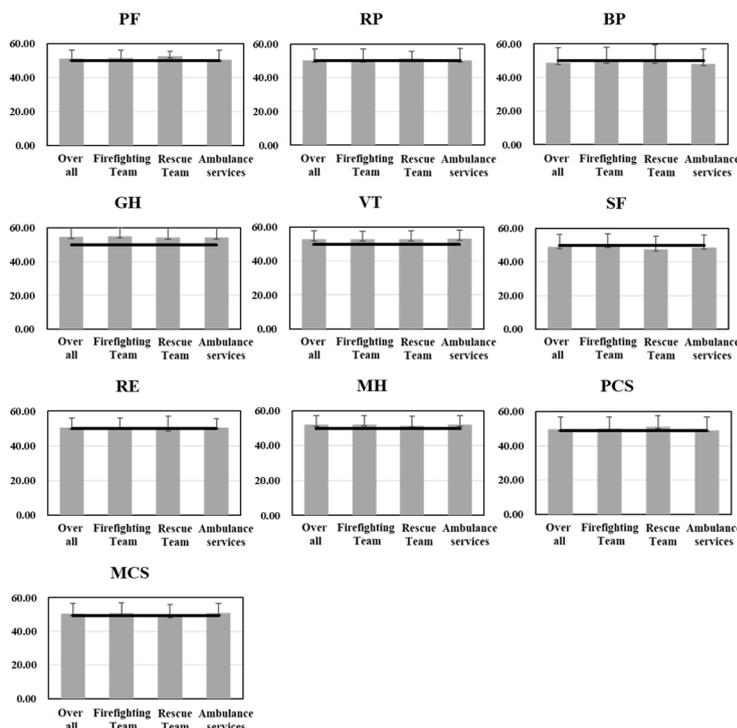


Figure 1. Comparison of SF-8 item scores with the national standard average values in Japan, stratified by firefighter and assignment. The black bold line represents the national standard average values in Japan. PF, physical functioning; RP, role physical; BP, bodily pain; GH, general health; VT, vitality; SF, social functioning; RE, role emotional; MH, mental health; PCS, physical summary scores; MCS, mental summary scores.

Table 1. Firefighter characteristics and SF-8 item scores

Items	n	%	p-value									
			PF	RP	BP	GH	VT	SF	RE	MH	PCS	MCS
Affiliation												
Firefighting team	102	47.5	0.327	0.873	0.511	0.939	0.834	0.313	0.972	0.852	0.692	0.636
Rescue team	22	10.2										
Ambulance services	91	42.3										
Age groups												
< 20	2	1.0	0.340	0.855	0.355	0.808	0.257	0.543	0.426	0.712	0.501	0.894
20-29	79	36.7										
30-39	77	35.8										
40-49	49	22.8										
50-59	5	2.3										
≥ 60	3	1.4										
Sex												
Male	208	96.7	0.233	0.348	0.594	0.159	0.768	0.680	0.695	0.376	0.202	0.591
Female	7	3.3										
Living with family												
Yes	191	88.8	0.199	0.017*	0.109	0.036*	0.095	0.406	0.859	0.046*	0.110	0.359
No	24	11.2										
Lack of sleep												
Yes	37	17.2	0.005**	0.007**	0.024*	0.089	0.004**	0.000**	0.001**	0.007**	0.023*	0.004**
No	178	82.8										
Exercise frequency per week												
1 to 2 times	76	35.4	0.399	0.568	0.542	0.030*	0.366	0.281	0.888	0.824	0.487	0.961
3 to 4 times	111	51.6										
≥ 5 times	28	13.0										

PF, physical functioning; RP, role physical; BP, bodily pain; GH, general health; VT, vitality; SF, social functioning; RE, role emotional; MH, mental health; PCS, physical summary scores; MCS, mental summary scores; * $p < 0.05$; ** $p < 0.01$.

Table 2. SF-8 item scores stratified by COVID-19-related characteristics

Items	n	%	p-value									
			PF	RP	BP	GH	VT	SF	RE	MH	PCS	MCS
History of suspected COVID-19 infection												
Yes	28	13.0	0.408	0.376	0.024*	0.048*	0.130	0.114	0.083	0.407	0.171	0.668
No	187	87.0										
Experience of transporting COVID-19 patients												
Yes	151	70.2	0.086	0.207	0.289	0.729	0.210	0.028*	0.949	0.770	0.234	0.729
No	64	29.8										
SARS-CoV-2 vaccination												
Yes	199	92.6	0.048*	0.091	0.047*	0.470	0.238	0.047*	0.732	0.423	0.079	0.764
No	16	7.4										
Physical abnormalities due to the infection control												
Yes	30	14.0	0.062	0.028*	0.046*	0.357	0.079	0.011*	0.003**	0.081	0.123	0.088
No	185	86.0										

PF, physical functioning; RP, role physical; BP, bodily pain; GH, general health; VT, vitality; SF, social functioning; RE, role emotional; MH, mental health; PCS, physical summary scores; MCS, mental summary scores; COVID-19, coronavirus disease 2019; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2; * $p < 0.05$; ** $p < 0.01$.

0.007), physical summary scores ($p = 0.023$), and mental summary scores ($p = 0.004$) were significantly lower in the participants that reported insufficient sleep than in those that did not report insufficient sleep. Participants that exercised once or twice per week had significantly lower general health ($p = 0.030$) scores than the other groups.

3.4. SF-8 scores by COVID-19 status

The SF-8 scores associated with COVID-19-related items are presented in Table 2. The participants with history of

suspected infection had significantly lower bodily pain ($p = 0.024$) and general health ($p = 0.048$) scores than those without history of suspect an infection. The participants that had transported COVID-19 patients had significantly lower social functioning ($p = 0.028$) scores than those that did not transport any COVID-19 patients. The participants that had received the SARS-CoV-2 vaccine had significantly lower physical functioning ($p = 0.048$), bodily pain ($p = 0.047$), and social functioning ($p = 0.047$) scores than the participants that had not received the vaccine. The participants with physical abnormalities due to infection control had significantly lower role physical

Table 3. Regression analysis result

Items	Partial regression coefficient	Standard partial regression coefficient	95% CI		p-value	
			Lower limit	Upper limit		
PF	Lack of sleep	-2.072	-0.158	-3.822	-0.323	0.020*
	SARS-CoV-2 vaccination status	-2.164	-0.114	-4.680	-0.353	0.092
RP	Living with family	2.518	0.119	-0.262	5.297	0.076
	Lack of sleep	-2.694	-0.153	-5.019	-0.369	0.023*
BP	Physical abnormalities due to infection control measures	-3.196	-0.119	-5.733	-0.660	0.014*
	Lack of sleep	-2.882	-0.122	-5.997	0.234	0.070
	Suspected COVID-19 infection	-3.858	-0.146	-7.336	-0.380	0.030*
	SARS-CoV-2 vaccination	-4.008	-0.118	-8.472	0.456	0.078
GH	Physical abnormalities due to infection control measures	-3.030	-0.118	-6.428	0.368	0.080
	Living with family	2.643	0.143	0.207	5.080	0.034*
	Exercise frequency: 3-4 times/week (vs. 1-2 times/week)	2.027	0.174	0.348	3.706	0.018*
	Exercise frequency ≥ 5 times/week (vs. 1-2 times/week)	2.900	0.168	0.423	5.377	0.022*
VT	History of suspected COVID-19 infection	-2.162	-0.125	-4.450	0.127	0.064
	Lack of sleep	-2.788	-0.213	-4.512	-1.064	0.002**
SF	Lack of sleep	-4.001	-0.204	-6.629	-1.373	0.003**
	Experience of transporting COVID-19 patients	-0.891	-0.055	-3.067	1.285	0.420
	SARS-CoV-2 vaccination	-2.874	-0.102	-6.562	0.815	0.126
	Physical abnormalities due to infection control measures	-3.037	-0.142	-5.825	-0.250	0.033*
RE	Lack of sleep	-3.218	-0.228	-5.057	-1.380	0.001**
	Physical abnormalities due to infection control measures	-2.381	-0.155	-4.384	-0.378	0.020*
MH	Living with family	2.819	0.173	0.675	4.963	0.010*
	Lack of sleep	-2.271	-0.167	-4.060	-0.483	0.013*
PCS	Lack of sleep	-2.677	-0.143	-5.179	-0.175	0.036*
MCS	Lack of sleep	-2.944	-0.183	-5.077	-0.812	0.007**

PF, physical functioning; RP, role physical; BP, bodily pain; GH, general health; VT, vitality; SF, social functioning; RE, role emotional; MH, mental health; PCS, physical summary scores; MCS, mental summary scores; COVID-19, coronavirus disease 2019; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2; CI, confidence interval; * $p < 0.05$; ** $p < 0.01$.

($p = 0.028$), bodily pain ($p = 0.046$), social functioning ($p = 0.011$), and role emotional ($p = 0.003$) scores than the participants without any such abnormalities.

3.5. Regression analysis

Regression analysis revealed that physical functioning scores were associated with lack of sleep ($p = 0.020$). Role physical scores were associated with lack of sleep deprivation ($p = 0.023$) and physical abnormalities due to infection control ($p = 0.014$). Bodily pain scores were associated with a history of suspected infection ($p = 0.030$). General health scores were significantly associated with the co-residence status ($p = 0.034$), exercising 3-4 times/week or more (vs. 1-2 times/week) ($p = 0.018$), and exercising > 5 times/week (vs. 1-2 times a week) ($p = 0.022$). Vitality scores were associated with lack of sleep ($p = 0.002$). Social functioning scores were significantly associated with lack of sleep ($p = 0.003$) and physical abnormalities due to infection control measures ($p = 0.033$). Role emotional scores were significantly associated with the experience of lack of sleep ($p = 0.001$) and physical abnormalities due to infection control ($p = 0.020$). Mental health scores were significantly related to living with family ($p = 0.010$) and perceived lack of sleep ($p = 0.013$). There was a significant relationship between physical summary scores and lack of sleep ($p = 0.036$). There was a significant relationship between

mental summary scores and lack of sleep ($p = 0.007$) (Table 3). Multicollinearity between each independent variable was not identified.

4. Discussion

This study investigated factors affecting HRQOL among firefighters affiliated with a single organization during the fourth COVID-19 epidemic in Japan. Lack of sleep, exercise habits, living with family members, history of suspected COVID-19 infection, and physical abnormality due to infection control measures are associated with HRQOL of firefighters. This is the first study to investigate the HRQOL of firefighters in the context of the COVID-19 pandemic in Japan.

In simple comparisons, bodily pain and social functioning scores of the present study participants were lower than those of the general Japanese population. A previous study noted that firefighters had a higher prevalence of musculoskeletal symptoms than the general population due to occupational stress (10). The present study subjects may have experienced extra workload and increased burden of infection control due to the COVID-19 pandemic, which may have led to physical pain. This evidence suggests that firefighters may require interventions to ease their physical and mental burdens. The low social functioning scores indicate that firefighters have reduced social interaction with family,

friends, and neighbors, which may affect their social functioning during the COVID-19 pandemic. Therefore, the requirement to self-isolate to prevent infection spread may be a source of concern for firefighters. However, to the best of our knowledge, only a limited number of studies have examined health-related quality of life using the scale we used (SF-8) in firefighter team, rescue team, and ambulance services. In addition, prior studies (11) did not present data for each subitem such as bodily pain and social functioning for firefighters. Therefore, it was difficult to compare data from this study with data from before the COVID-19 pandemic.

We hypothesized that the COVID-19 outbreak would have a particularly detrimental effect on HRQOL of paramedics who have frequent contact with suspected infected patients. However, in the present study, there was no difference in the SF-8 scores among the participants affiliated with different divisions. Therefore, first responders requiring support during the COVID-19 pandemic include all ambulance, fire-fighting, and rescue teams. Firefighters respond to emergency calls, including fires, and rescue and ambulance calls. In Japan, there are numerous fire department; firefighters are trained and expected to respond to emergency calls.

Prolonged COVID-19 pandemic may increase the risk to physical and psychological illness, including burnout (12,13). This finding suggests the need for interventions to protect the HRQOL of first responders, such as firefighters. Social isolation has been identified as a risk factor for death (14), which is a cause of concern during the COVID-19 pandemic. In the present study, the firefighters who lived with their families had higher general health and mental health scores, suggesting that family support increases HRQOL and helps their physical and mental health.

Stress is a major cause of insomnia (15). Frontline staff managing patients with suspected or confirmed COVID-19 diagnosis report high rates of insomnia, anxiety, and depression (16,17). In the present study, physical functioning, role physical, vitality, social functioning, role emotional, mental health, physical summary scores, and mental summary scores were affected by the lack of sleep. Firefighters suffer from sleep disorders due to the nature of their work (18). In addition, the response to the COVID-19 pandemic required that working hours be extended, reducing rest and sleep time, both of which may have affected the SF-8 item scores.

Physical infection control measures affected role physical, social functioning, and role emotional scores possibly due to their increased use when responding to emergency calls during the COVID-19 pandemic. Previous studies have reported the negative impact of personal protective equipment use on the physical and mental health of healthcare workers (19). Wearing personal protective equipment above and beyond that required for routine activities may exacerbate physical

and mental fatigue and affect performance due to factors such as heat stress, hearing and vision impairment, and restricted movement (19). Although the use of personal protective gear during the COVID-19 pandemic is necessary to manage infection risks, it may also affect physical and mental health.

Exercise habits had positive effects on general health scores. Physical activity and exercise help reduce the levels of anxiety, stress, and depression, and improve overall physical and mental health (20). The present findings suggest that even among the participants that were required to change their lifestyle and social habits, engaging in exercise may help reduce the levels of depression and anxiety, and maintain well-being during the COVID-19 pandemic.

In this study, firefighters with a history of suspected COVID-19 infection were found to have lower bodily pain scores. Suspected COVID-19 infection increases the levels of stress and anxiety and may cause disruptions to the activities of daily living. Meanwhile, stress and anxiety can develop into subjective symptoms of pain, which may affect job performance. Previous studies have examined the impact of the COVID-19 pandemic on pain levels (21). Cases of suspected infection may be impossible to avoid among firefighters; however, support systems for suspected cases should be strengthened to help reduce work- and life-related stress levels.

This study had several limitations. First, this study had a small sample size and was based at a single center, which limits the generalizability of the present findings. Second, lack of sleep, living with family members, and exercise habits may contribute to HRQOL outside of the COVID-19 pandemic. Third, this study was cross-sectional, observing effects in June 2021, and precluding any conclusions about changes over time. Finally, the SF-8 questionnaire measures HRQOL by retrospectively assessing each item during the previous month; consequently, the present study did not assess the entire period between the initial COVID-19 outbreak and it becoming a pandemic.

However, the strength of this study is that it is first to examine the determinants of HRQOL among firefighters in Japan during the pandemic. The present findings may be used to design future interventions aimed at supporting first responders providing pre-hospital care in contexts associated with high risks of infection.

5. Conclusions

In the present study, factors affecting HRQOL among firefighters during the COVID-19 pandemic were lack of sleep, exercise habits, living with family members, history of suspected COVID-19 infection, and physical abnormalities due to infection control measures. The present findings may inform the development of interventions aimed at supporting first responders, such as firefighters, in future pandemics.

Acknowledgements

We greatly appreciate all firefighters for their participation in this study. We would like to thank Editage (www.editage.com) for English language editing.

Funding: This work was supported by the Chubu University under Grant [number 21M09R].

Conflict of Interest: The authors have no conflicts of interest to disclose.

References

- Zhu N, Zhang D, Wang W, *et al.* A novel coronavirus from patients with pneumonia in China, 2019. *N Engl J Med.* 2020; 382:727-733.
- Gualano MR, Lo Moro G, Voglino G, Bert F, Siliquini R. Effects of Covid-19 lockdown on mental health and sleep disturbances in Italy. *Int J Environ Res Public Health.* 2020; 17:4779
- Caban-Martinez AJ, Schaefer-Solle N, Santiago K, Louzado-Feliciano P, Brotons A, Gonzalez M, Issenberg SB, Kobetz E. Epidemiology of SARS-CoV-2 antibodies among firefighters/paramedics of a US fire department: a cross-sectional study. *Occup Environ Med.* 2020; 77:857-861.
- Prezant DJ, Zeig-Owens R, Schwartz T, Liu Y, Hurwitz K, Beecher S, Weiden MD. Medical leave associated with COVID-19 among emergency medical system responders and firefighters in New York city. *JAMA Netw Open.* 2020; 3:e2016094.
- DePierro J, Lowe S, Katz C. Lessons learned from 9/11: Mental health perspectives on the COVID-19 pandemic. *Psychiatry Res.* 2020; 288:113024.
- Skoda EM, Teufel M, Stang A, Jöckel KH, Junne F, Weismüller B, Hetkamp M, Musche V, Kohler H, Dörrle N, Schweda A, Bäuerle A. Psychological burden of healthcare professionals in Germany during the acute phase of the COVID-19 pandemic: differences and similarities in the international context. *J Public Health (Oxf).* 2020; 42:688-695.
- Lefante JJ, Harmon GN, Ashby KM, Barnard D, Webber LS. Use of the SF-8 to assess health-related quality of life for a chronically ill, low-income population participating in the Central Louisiana Medication Access Program (CMAP). *Qual Life Res.* 2005; 14:665-673.
- Kiyohara K, Itani Y, Kawamura T, Matsumoto Y, Takahashi Y. Changes in the SF-8 scores among healthy non-smoking school teachers after the enforcement of a smoke-free school policy: a comparison by passive smoke status. *Health Qual Life Outcomes.* 2010; 8:44.
- Tokuda Y, Okubo T, Ohde S, Jacobs J, Takahashi O, Omata F, Yanai H, Hinohara S, Fukui T. Assessing items on the SF-8 Japanese version for health-related quality of life: a psychometric analysis based on the nominal categories model of item response theory. *Value Health.* 2009; 12:568-573.
- 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.
- Vinnikov D, Tulekov Z, Akylzhanov A, Romanova Z, Dushpanova A, Kalmatayeva Z. Age and work duration do not predict burnout in firefighters. *BMC Public Health.* 2019; 19:308.
- Soto-Rubio A, Giménez-Espert MDC, Prado-Gascó V. Effect of emotional intelligence and psychosocial risks on burnout, job satisfaction, and nurses' health during the COVID-19 pandemic. *Int J Environ Res Public Health.* 2020; 17:7998.
- Smith TD, DeJoy DM, Dyal MA, Huang G. Impact of work pressure, work stress and work-family conflict on firefighter burnout. *Arch Environ Occup Health.* 2019; 74:215-222.
- Elovainio M, Hakulinen C, Pulkki-Råback L, Virtanen M, Josefsson K, Jokela M, Vahtera J, Kivimäki M. Contribution of risk factors to excess mortality in isolated and lonely individuals: an analysis of data from the UK Biobank cohort study. *The Lancet Public Health.* 2017; 2:e260-e266.
- Kalmbach DA, Anderson JR, Drake CL. The impact of stress on sleep: Pathogenic sleep reactivity as a vulnerability to insomnia and circadian disorders. *J Sleep Res.* 2018; 27:e12710.
- Firew T, Sano ED, Lee JW, Flores S, Lang K, Salman K, Greene MC, Chang BP. Protecting the front line: A cross-sectional survey analysis of the occupational factors contributing to healthcare workers' infection and psychological distress during the COVID-19 pandemic in the USA. *BMJ Open.* 2020; 10:e042752.
- Zhang C, Yang L, Liu S, Ma S, Wang Y, Cai Z, Du H, Li R, Kang L, Su M, Zhang J, Liu Z, Zhang B. Survey of insomnia and related social psychological factors among medical staff involved in the 2019 novel coronavirus disease outbreak. *Front Psychiatry.* 2020; 11:306.
- Khan WAA, Conduit R, Kennedy GA, Abdullah Alslamah A, Ahmad Alsuwayeh M, Jackson ML. Sleep and mental health among paramedics from Australia and Saudi Arabia: A comparison study. *Clocks Sleep.* 2020; 2:246-257.
- Ruskin KJ, Ruskin AC, Musselman BT, Harvey JR, Nesthus TE, O'Connor M. COVID-19, personal protective equipment, and human performance. *Anesthesiology.* 2021; 134:518-525.
- Peluso MA, Guerra de Andrade LH. Physical activity and mental health: The association between exercise and mood. *Clinics (Sao Paulo).* 2005; 60:61-70.
- Majumdar P, Biswas A, Sahu S. COVID-19 pandemic and lockdown: Cause of sleep disruption, depression, somatic pain, and increased screen exposure of office workers and students of India. *Chronobiol Int.* 2020; 37:1191-1200.

Received November 8, 2022; Revised January 21, 2023; Accepted January 24, 2023.

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Released online in J-STAGE as advance publication February 2, 2023.