
Factors Associated With Work Fatigue Among Fire Department Officers In Jambi City

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Abstract

Work fatigue is an occupational health issue that can reduce productivity, elevate the risk of workplace accidents, and threaten worker safety, particularly in high-risk occupations such as firefighting. This study examined the factors associated with work fatigue among officers of the Jambi City Fire Department, covering age, length of service, body mass index, smoking habits, workload, sleep quality, and heat exposure. A cross-sectional quantitative design was applied, involving all officers who met the inclusion criteria through a total sampling technique, yielding 192 respondents. Data were collected using standardized questionnaires and analyzed through univariate and bivariate chi-Square tests at a significance level of 0.05. The findings showed that 86.5% of respondents experienced a high level of work fatigue. No significant association was found between age ($p=0.145$), length of service ($p=0.099$), or body mass index ($p=0.509$) and work fatigue, whereas smoking behavior ($p=0.018$; $PR=1.163$), workload ($p=0.025$; $PR=1.154$), sleep quality ($p=0.001$; $PR=1.218$), and heat exposure ($p=0.019$; $PR=1.195$) were significantly associated with it. These four factors are therefore the main determinants of work fatigue among firefighters, and the institution is expected to design interventions addressing sleep management, workload distribution, smoking-cessation support, and heat-exposure control in the workplace.

Keywords: Work Fatigue, Workload, Sleep Quality, Heat Exposure, Firefighters

INTRODUCTION

According to a joint report by the WHO and the ILO, nearly two million workers worldwide die each year from work-related diseases and accidents, with the majority of these deaths stemming from chronic stress and long working hours that contribute to fatigue (World Health Organization, 2021). Recent global estimates even show an increase in the number of work-related deaths from 2.78 million in 2015 to 2.9 million in 2019, accompanied by an increase in years of life lost due to work-related disabilities (Takala et al., 2024).

In Indonesia, the trend of workplace accidents has also shown a consistent increase. Data from the Ministry of Manpower recorded more than 370,000 cases of workplace accidents in 2023 (Ministry of Manpower of the Republic of Indonesia, 2023), while the Social Security Agency for Employment (BPJS Ketenagakerjaan) reported a surge in workplace accident claims from approximately 182,000 cases in 2019 to more than 360,000 cases in 2023 (BPJS Ketenagakerjaan, 2024). Some of these incidents are suspected to be related to worker fatigue, given that another study found that nearly a third of daily workplace accidents are related to fatigue (Santosa, 2024).

Occupational fatigue itself is understood as a decrease in a person's efficiency and endurance in carrying out their duties, which ultimately reduces work capacity and increases the risk of errors and accidents (Tarwaka, 2019). In the firefighting profession, the risk of occupational fatigue is high due to heavy physical demands, exposure to extreme temperatures during firefighting, and shift work patterns that disrupt rest and recovery time (National Institute for Occupational Safety and Health, 2022; World Health Organization, 2023).

A similar situation is evident in Jambi City. Data from the Jambi City Fire Department recorded 119 fire incidents as of September 2024 (Jambi City Fire Department, 2024), with six teams working 24-hour shifts and a weekly workload of 48 to 72 hours, exceeding the recommended 40-hour week (Government Regulation of the Republic of Indonesia, 2020). These operational conditions have the potential to accelerate work fatigue and reduce officer preparedness in responding to emergencies.

Previous studies have shown inconsistent results regarding factors associated with work fatigue in high-risk professions. Izhar et al. (2024) found a negative relationship between age and length of service with fatigue in oil and gas workers in Jambi Province, while Dengo et al. (2023) reported a high prevalence of fatigue in Gorontalo Regional Disaster Management Agency (BPBD) officers with no significant association with age or length of service. Lin et al.'s (2022) study of firefighters in Taiwan also showed that long work periods and an on-call system were major risk factors for sleep quality disorders.

Based on the variations in these findings and the difficult operational conditions at the Jambi City Fire Department, this study aims to analyze factors related to work fatigue in firefighters in the city, including age, length of service, body mass index, smoking behavior, workload, sleep quality, and heat exposure.

RESEARCH METHODS

This study used a quantitative approach with a cross-sectional analytical observational design to determine factors associated with work fatigue in firefighters. The study was conducted at the Jambi City Fire Department from November to December 2025.

The study population was all firefighters actively serving in the Jambi City Fire Department in 2025, totaling 192 people. The sample was taken using a total sampling technique (census) from all members of the population who met the inclusion criteria, namely being at least 18 years old, having worked for at least one year, and willing to complete the questionnaire and sign the informed consent. Officers who were on long leave, not actively on duty, or had incomplete demographic data were excluded from the sample, so that all 192 officers who met the criteria became research respondents.

Data were collected through questionnaires covering respondent characteristics (age, length of service, body mass index, and smoking status) and a standardized questionnaire to measure work fatigue adapted from the Industrial Fatigue Research Committee (IFRC), sleep quality, workload based on work pulse rate, and perception of heat exposure using the Heat Strain Score Index (HSSI) instrument. Work fatigue was categorized into moderate (score 0-44) and high (score 44-90); age was grouped into early adulthood (18-40 years) and middle adulthood (41-60 years); work period was divided into new workers (<1 year) and long-term workers (≥ 2 years); body mass index was categorized as low risk (18.5-25.0) and high risk (outside the range); workload was categorized as light (≤ 100 beats/min) and heavy (> 100 beats/min); sleep quality was categorized as undisturbed and disturbed based on the mean score; and heat exposure was categorized as light and heavy based on the HSSI questionnaire score.

Data processing was carried out through editing, coding, entry, and cleaning stages before being analyzed using statistical software. Univariate analysis was used to describe the frequency distribution of each variable, while bivariate analysis used the Chi-Square test to examine the relationship between independent variables and work fatigue at a significance level of $\alpha = 0.05$. The Prevalence Ratio (PR) value along with its 95% confidence interval was also calculated to assess the risk of each factor on the occurrence of work fatigue. This study has adhered to the principles of research ethics, including respondent consent (informed consent) and the confidentiality of participants' personal data.

RESULTS AND DISCUSSION

The results of the univariate analysis showed that of the 192 respondents, 166 (86.5%) experienced high levels of work fatigue, and 26 (13.5%) experienced moderate levels of work fatigue. The distribution of respondent characteristics and other research variables is presented in Table 1.

Table 1. Frequency Distribution of Research Variables on Jambi City Firefighters (n=192)

Variables	Category	n	%
Work Fatigue	Tall	166	86.5
	Currently	26	13.5
Age	Early Adulthood	103	53.6
	Middle Adult	89	46.4
Years of service	New Workers	60	31.3
	Old Worker	132	68.8
Body Mass Index	Low Risk	170	88.5
	High Risk	22	11.5
Smoking Status	Smoke	111	57.8
	Do not smoke	81	42.2
Workload	Heavy	109	56.8
	Light	83	43.2
Sleep Quality	Disturbed	97	50.5
	Undisturbed	95	49.5
Heat Exposure	Heavy	143	74.5
	Light	49	25.5

Source: Processed Primary Data, 2026

The results of the bivariate analysis using the Chi-Square test showed that of the seven variables studied, four variables were proven to be significantly related to work fatigue, namely smoking behavior, workload, sleep quality, and heat exposure, while age, length of service, and body mass index did not show a statistically significant relationship. Details of the bivariate test results are presented in Table 2.

Table 2. Results of Bivariate Analysis of Factors Related to Work Fatigue

Variables	Category	High Fatigue %	PR (95% CI)	p
Age	Early Adulthood / Middle Adulthood	90.3 / 82.0	0.908 (0.809-1.020)	0.145
Years of service	New Workers / Old Workers	93.3 / 83.3	0.893 (0.806-0.989)	0.099
Body Mass Index	High Risk / Low Risk	81.8 / 87.1	0.940 (0.765-1.154)	0.509
Smoking Behavior	Smoking / Non-Smoking	96.0 / 79.0	1,163 (1,026-1,318)	0.018*
Workload	Heavy / Light	91.7 / 79.5	1,154 (1,020-1,305)	0.025*
Sleep Quality	Disturbed / Not Disturbed	94.8 / 77.9	1,218 (1,083-1,368)	0.001*

Variables	Category	High Fatigue %	PR (95% CI)	p
Heat Exposure	Heavy / Light	90.2 / 75.5	1,195 (1,010-1,414)	0.019*

Source: Processed Primary Data, 2026; *significant at p<0.05

The high prevalence of work fatigue in this study aligns with the characteristics of firefighters' jobs, which require high levels of physical fitness, heavy use of personal protective equipment, and exposure to extreme environmental temperatures during firefighting operations. These working conditions require significant energy expenditure in a short period of time, accelerating the decline in work capacity and endurance.

The age variable did not show a significant relationship with work fatigue in this study (p=0.145). This result aligns with the findings of Wasiyem et al. (2025) and Maulina & Syafitri (2021), who also found no significant relationship between age and work fatigue. However, it differs from the findings of Melani (2023), who reported a significant relationship in construction workers. This insignificant relationship is likely due to the fact that most respondents are still in their productive age range, so their physical capacity to cope with work demands is relatively adequate.

The work period variable was also not significantly related to work fatigue (p=0.099), in line with research by Rumengan & Kandou (2025) and Ramadanti et al. (2025) who found a similar pattern in hospital and community health center nurses. Different results were reported by Iwan et al. (2025) and Mustakim & Pratiwi (2025) who found a significant relationship in industrial and loading and unloading workers. The relatively short and homogeneous work periods of the respondents in this study are thought to be the cause of the lack of statistically significant differences in fatigue levels between work period groups.

Body mass index was also not significantly associated with work fatigue (p=0.509), consistent with the results of Farihatin et al. (2022) and Carela (2021), which also found no significant association. Conversely, Nur Aisyah & Basri (2021) and Sihalofo et al. (2024) reported a significant association in other worker populations. Most respondents in this study were in the low-risk BMI category, so the variation in nutritional status between groups was relatively small to produce significant differences in work fatigue.

Smoking behavior was shown to be significantly associated with work fatigue (p=0.018; PR=1.163), in line with Iwan et al. (2025) and Damayanti et al. (2021), although Fitria et al. (2023) and Manan et al. (2024) reported opposite results in expedition drivers and couriers. The nicotine and carbon monoxide content in cigarettes is thought to reduce the blood's capacity to transport oxygen to muscle tissue and the brain, making workers who smoke more susceptible to decreased physical and mental capacity.

Workload was also shown to be significantly associated with job fatigue (p=0.025; PR=1.154), in line with Tempo et al. (2025) and Mangowal et al. (2023), but in contrast to Pangestu et al. (2025) who found no significant relationship in hospital nurses. An imbalance between job demands and individual work capacity is a major determinant of fatigue, especially in jobs with high physical demands such as firefighting.

Sleep quality has been shown to be a significant risk factor for work fatigue (p=0.001; PR=1.218), consistent with a systematic review by Armadani & Paskarini (2023) and research by Mustakim & Pratiwi (2025). Sleep plays a crucial role in physical and mental recovery; sleep disruption due to the 24-hour shift system in firefighting results in suboptimal recovery, accelerating the onset of fatigue on the following workday.

Heat exposure was also shown to be significantly associated with work fatigue (p=0.019; PR=1.195), consistent with research by Kartika et al. (2021) and Aprilina (2021) on construction workers. Excessive heat exposure forces the body to work harder to maintain core temperature through peripheral vasodilation and increased sweat production, thereby accelerating body fluid loss and reducing physical work capacity. Different results were found by Ariscasari et al. (2024), who stated

that there was no significant relationship between several individual factors and heat stress complaints if heat risk control in the work environment had been adequately implemented.

Several limitations should be considered when interpreting the results of this study. The variables of sleep quality, smoking behavior, heat exposure, and work fatigue were measured using a questionnaire that relies on respondents' perceptions and memories, potentially introducing information bias. The cross-sectional design also limits the study's ability to establish a causal relationship between the independent variables and work fatigue.

CONCLUSIONS

This study shows that the proportion of high category work fatigue among Jambi City Fire Department officers is relatively high, reaching 86.5% of 192 respondents. The results of the bivariate analysis revealed that age, length of service, and body mass index were not significantly related to work fatigue, while smoking behavior, workload, sleep quality, and heat exposure proved to be risk factors that were significantly related to work fatigue of officers. These findings confirm that aspects of lifestyle and physical working conditions have a more dominant role than demographic characteristics in determining the level of work fatigue in the firefighting profession. So that the Jambi City Fire Department is advised to design a more proportional work and rest schedule policy, provide facilities for controlling heat exposure, support smoking cessation programs, and improve rest facilities to support the quality of sleep of officers as an effort to reduce the risk of work fatigue and improve overall work safety.

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