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Occupational stress and work fatigue among vessel crews

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Abstract

Background: Fatigue contributes to approximately 20% of occupational incidents and is identified as an underlying factor in 25% of fatal and serious accidents. This condition is often exacerbated by high job demands, which can induce emotional strain in the form of occupational stress. Globally, occupational stress affects an estimated 264 million workers.
Purpose: To analyze the relationship between occupational stress and work fatigue among small-vessel crew members at PT X.
Method: This quantitative study used a cross-sectional design involving 54 small-vessel crew members. Data were collected using the Multidimensional Fatigue Inventory (MFI-20) and Depression Anxiety Stress Scale (DASS-21) questionnaires. The data were analyzed using the chi-square test.
Results: A significant relationship was found between occupational stress and work fatigue among small-vessel crew members, with a significance value of 0.013 ($p < 0.05$) and an odds ratio (OR) of 5.714. Among small-vessel crew members experiencing occupational stress, 23 individuals (95.8%) also experienced work fatigue.
Conclusion: The findings indicate that occupational stress is significantly associated with work fatigue and represents an important risk factor for fatigue development among small-vessel crew members. Small-vessel crew members experiencing occupational stress had 5.714 times higher odds of experiencing occupational fatigue compared with those without occupational stress.

Keywords: Occupational Stress; Vessel Crews; Work Fatigue.

INTRODUCTION

In modern work environments, high job demands, excessive workloads, and extended working hours often trigger disproportionate physical and emotional responses, becoming major contributors to occupational stress. When unmanaged and sustained over time, chronic occupational stress can impair physical endurance, reduce stamina, and compromise operational performance, ultimately contributing to the development of work-related fatigue. In the oil and gas industry, fatigue remains a significant contributor to occupational incidents. Between 2020 and 2024, a total of 826 occupational accidents were recorded, consisting of 21 catastrophic incidents, 248 major incidents, 54 serious incidents, and 503 other categorized incidents. Fatigue contributed to 20% of all recorded incidents and was identified as an underlying cause in 25% of fatal and serious accidents (International Association of Oil & Gas Producers, 2025).

In Indonesia, the Ministry of Manpower of the Republic of Indonesia, through the Directorate General of Labor Inspection and Occupational Safety and Health Development, reported 7,298 occupational accidents in 2021. Among these cases, 9% were confirmed to be associated with fatigue-related conditions (Ministry of Manpower of the Republic of Indonesia, 2022).

Work fatigue is highly prevalent in the maritime sector, where prolonged working hours, demanding operational conditions, and safety-critical tasks

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increase the risk of human performance impairment. A review conducted by the International Maritime Organization (IMO) on maritime incidents indicated that human error is the predominant contributing factor in vessel accidents, accounting for approximately 80% of cases, while fleet conditions and navigational environments account for the remaining 20% (Wahyuni & Rahmawati, 2018).

At the national level, maritime safety conditions in Indonesia are reflected in data from the National Transportation Safety Committee (*KNKT*), which recorded 15 maritime incidents during the first half of 2021. These incidents involved various accident types, including grounding, sinking, fire, and collision. Furthermore, an analysis of maritime accidents from 2018 to the first semester of 2021 identified 44 contributing determinants. Technical failures were the most frequently identified factor, accounting for 23 incidents, followed by human factors or human error, which contributed to 21 incidents (Gustian et al., 2025).

The phenomenon of work fatigue is closely associated with psychosocial dimensions, particularly workers' perceptions and experiences of exhaustion (Kawatu, 2021). This condition is often intensified by high job demands, which may generate emotional strain in the form of occupational stress. Occupational stress represents a significant psychological burden that can adversely affect work quality, individual behavior, and overall productivity (Jacobs et al., 2024). Globally, occupational stress affects at least 264 million workers and contributes to increased absenteeism, resulting in economic losses of up to USD 300 billion annually due to reduced productivity (International Labour Organization, 2022).

The severity of this issue is also reflected in the United Kingdom's Labour Force Survey in 2014, which reported 440,000 cases of work-related stress, corresponding to a prevalence rate of 1,380 cases per 100,000 workers. Occupational stress was associated with 35% of fatal incidents and accounted for 43% of lost productive working days (Mayang, 2018). In Indonesia, a 2014 Ministry of Health survey reported that occupational stress was among the key determinants contributing to occupational accidents and diseases, which collectively accounted for approximately 2 million deaths annually worldwide (Yulius & Lubis, 2021). This issue persists, as evidenced by 2021 data from the Indonesian Ministry of Manpower revealing that over two-thirds (68%) of the national workforce suffers from moderate to severe stress (Ministry of Manpower of the Republic of Indonesia, 2021).

Theoretically, occupational stress can manifest through physiological changes, behavioral and mental fluctuations, and emotional responses among workers (Tarwaka, 2015). This mechanism is consistent with Hans Selye's General Adaptation Syndrome (GAS) concept, which explains that the human body responds to stressors through a non-specific physiological adaptation process consisting of three stages: the Alarm Reaction stage, the Resistance (adaptation) stage, and the Exhaustion stage. Prolonged exposure to stressors may disrupt the adaptation process, eventually resulting in exhaustion and reduced functional capacity. This theoretical explanation is supported by findings demonstrating a significant relationship between occupational stress and work fatigue (Manaroinsong et al., 2022).

Ship crews represent one of the occupational groups with high vulnerability to psychosocial risks. Seafarers have been reported to experience a twofold higher risk of psychosocial occupational health and safety problems compared with shore-based workers (Carter, 2005). The nature of maritime work, including extended working hours, shift rotations, and exposure to dynamic environmental conditions, increases the potential for occupational stress and fatigue among small-vessel crew members.

The oil and gas industry is categorized as a high-risk sector requiring high levels of operational reliability and safety management. Within this sector, logistics and transportation activities remain critical components that may contribute to incident risks. Ship crews supporting oil and gas operations are frequently exposed to demanding work schedules, rotational shifts, and challenging marine environments, which may increase their susceptibility to occupational stress and fatigue. PT X is an oil and gas company that operates vessels to support its operational activities. One type of vessel commonly used for logistical support is the small marine vessel, which is selected due to its size and operational capability in shallow and narrow waters. These vessels are operated by two-person crews working under a shift system, potentially increasing exposure to fatigue-related occupational risks.

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RESEARCH METHOD

This study employed a cross-sectional design involving all small-vessel crew members supporting well intervention and drilling operations at PT X between March and June 2026. A total sampling technique was applied, whereby all 54 eligible crew members working on small marine vessels during the study period were invited to participate. All eligible participants met the predefined inclusion criteria and were enrolled in the study.

Work fatigue was assessed using the Multidimensional Fatigue Inventory-20 (MFI-20), while occupational stress was measured using the Indonesian version of the Depression Anxiety Stress Scales (DASS-21). Based on the MFI-20 total score, work fatigue was categorized into mild (≤38), moderate (39–56), and high (≥57). Occupational stress was classified according to the DASS-21 stress subscale into normal (≤14), mild (15–18), moderate (19–25), severe (26–33), and extremely severe (≥34).

The MFI-20 demonstrated acceptable psychometric properties, with item validity coefficients ranging from r = 0.400 to 0.696. One item (Item 2) did not meet the validity criterion and was excluded from further analysis. The instrument demonstrated good internal consistency, with a Cronbach's alpha coefficient of 0.870. Similarly, the DASS-21 stress subscale demonstrated excellent validity, with r values ranging from 0.815 to 0.905 and a Cronbach's alpha coefficient of 0.941. All invalid items were removed prior to statistical analysis.

Univariate descriptive analysis was performed to summarize respondents' characteristics, occupational stress, and work fatigue. Although descriptive statistics were presented using the original instrument categories, the variables included in the chi-square analysis were dichotomized. Work fatigue was categorized into low fatigue and high fatigue using the sample mean as the cut-off value, whereas occupational stress was dichotomized into normal and stress, with all stress categories (mild, moderate, severe, and extremely severe) combined into a single stress group.

Bivariate analysis was performed using the chi-square test to examine the association between occupational stress and work fatigue among the respondents. Statistical significance was set at $p < 0.05$, and the strength of the association was expressed as an odds ratio (OR) with a 95% confidence interval (95% CI).

This study was approved by the Ethics Committee of the Faculty of Public Health, Universitas Indonesia (Approval No. Ket-542/UN2.F10.ETK/PPM.00.02/2026). Written informed consent was obtained from all participants before data collection.

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RESEARCH RESULTS

Tabel 1. Characteristics of Respondent (N = 54)

Variables	Results	p-value	OR (CI 95%)
Age (Mean±SD)(Range)(Year)	(37.35±5.78)(21-56)		
Age (n/%)			
21 – 25	11/20.4		
26 – 35	15/27.8		
36 – 45	18/33.3		
46 – 56	10/18.5		
Job Position (n/%)			
Driver	35/64.8		
Helper	19/35.2		
Marital Status (n/%)			
Married	42/77.8		
Unmarried	12/22.2		
Work Fatigue (n/%)			
Mild	4/7.4		
Moderate	24/44.4		
High	26/48.2		
Occupational Stress (n/%)		0.013	5.714 (1.571-20.781)
Normal	30/55.6		
Mild	3/5.5		
Moderate	2/3.7		
Severe	4/7.4		
Extremely Severe	15/27.8		

A total of 54 small-vessel crew members participated in this study. The mean age of the respondents was 37.35 ± 5.78 years (range: 21–56 years). The largest proportion of participants was aged 36–45 years (33.3%), followed by those aged 26–35 years (27.8%). Most respondents worked as drivers (64.8%) and were married (77.8%).

Regarding work fatigue, nearly half of the respondents experienced high fatigue (48.2%), while 44.4% reported moderate fatigue and 7.4% reported mild fatigue. For occupational stress, more than half of the respondents were classified as normal (55.6%). However, 44.4% experienced some degree of occupational stress, including mild (5.5%), moderate (3.7%), severe (7.4%), and extremely severe stress (27.8%).

The chi-square analysis demonstrated a statistically significant association between occupational stress and work fatigue (p = 0.013). Crew members experiencing occupational stress had 5.714 times higher odds of experiencing work fatigue than those with normal stress levels (OR = 5.714; 95% CI: 1.571–20.781).

DISCUSSION

The Relationship Between Occupational Stress and Work Fatigue

The analysis revealed a significance value of 0.013 ($p < 0.05$), indicating a statistically significant relationship between occupational stress and work fatigue among the vessel crew members. An odds ratio of 5.714 demonstrates that crew members

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experiencing occupational stress had 5.714 times the odds of reporting work fatigue compared to their non-stressed counterparts. These findings align with previous research indicating a correlation between occupational stress and work fatigue, where 74 workers (61.7%) experienced work fatigue and 60 workers (50.0%) reported moderate occupational stress (Oktariani et al., 2022).

This finding is consistent with previous studies reporting that increased workload contributes to higher levels of occupational stress among seafarers and that prolonged exposure to excessive workload and occupational stress may lead to fatigue and eventually burnout (Sijabat & Hermawati, 2021). Similarly, a study showed that job stress is positively associated with job-related fatigue among transportation workers. Higher levels of job stress have been shown to increase job-related fatigue, which can further impair job performance and increase the risk of workplace accidents (Strahan et al., 2008; Useche et al., 2021; Nasution & Widanarko, 2023). Furthermore, the association between occupational stress and fatigue remained significant even after controlling for depression, suggesting that fatigue is independently related to occupational stress rather than merely reflecting depressive symptoms (Rose et al., 2017).

The antecedents of occupational stress can be broadly classified into individual and organizational factors. Individual factors include role conflict, role overload, and role ambiguity, whereas organizational factors include low team cohesion, limited opportunities for team-building, an unsupportive organizational culture, and inadequate career development opportunities (Tewal, 2017).

The relationship between occupational stress and work fatigue can be explained by the Job Demands–Resources (JD-R) model, which posits that excessive job demands, when not balanced by adequate job resources, initiate a health impairment process characterized by psychological strain, chronic fatigue, and declining psychological well-being (Demerouti et al., 2001). This theoretical proposition has been supported by empirical evidence showing that occupational stress significantly mediates the relationship between job demands and work fatigue among post-pandemic Malaysian seafarers, with fatigue subsequently impairing job performance (Zakariah et al., 2025).

The findings of the present study further suggest that occupational stress and work fatigue are interconnected consequences of prolonged exposure to adverse psychosocial working conditions rather than independent phenomena. This relationship is consistent with both the health impairment process described in the JD-R model and the resistance-to-exhaustion stages of the General Adaptation Syndrome (GAS), which explain how sustained exposure to occupational stressors progressively depletes workers' adaptive capacity and eventually manifests as fatigue (Demerouti et al., 2001; Selye, 1956). The odds ratio of 5.714 observed in this study indicates that crew members experiencing occupational stress were more than five times as likely to develop work fatigue than those without occupational stress. These findings provide empirical support for prioritizing workplace stress management interventions as a key strategy for fatigue prevention, particularly in the maritime sector where crew well-being is closely linked to operational reliability and vessel safety (Demerouti et al., 2001; Selye, 1956; Zakariah et al., 2025).

The respondents consisted of 35 drivers (64.8%) and 19 helpers (35.2%). Distinguishing between these occupational roles is important because drivers generally assume greater responsibility, including operational decision-making, navigation support, and maintaining sustained attention, resulting in higher cognitive demands than helpers. Differences in job demands across occupational roles may contribute to varying levels of occupational stress and work fatigue, as workers exposed to greater physical and psychological demands are more susceptible to health impairment when adequate job resources are unavailable (Demerouti et al., 2001). Similar findings have been reported among seafarers, where occupational stress and work strain differ significantly according to occupational group and onboard working conditions (Oldenburg et al., 2009).

The majority of respondents were married (77.8%). Marital status may increase psychosocial demands by requiring workers to balance occupational responsibilities with family obligations. In the maritime industry, prolonged periods at sea and extended separation from family may intensify these psychosocial pressures and contribute to occupational stress. According to the transactional theory of stress, individuals' appraisal of multiple role

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demands and available coping resources influences their stress responses, making work–family conflict an important psychosocial stressor (Folkman, 2020).

Work fatigue is defined as a reduction in physical and mental capacity resulting from prolonged work activities, characterized by decreased efficiency, alertness, and physical endurance in task performance. Fatigue may manifest as localized muscular fatigue or generalized mental fatigue (Grandjean, 1979). In the present study, the mean work fatigue score among the 54 respondents was 56, with scores ranging from 30 to 84. Based on the fatigue classification, 48.1% of respondents experienced high levels of fatigue, 44.4% experienced moderate fatigue, and 7.4% experienced low fatigue. These findings indicate that work fatigue is highly prevalent among small-vessel crew members, with more than 90% of respondents classified as having moderate-to-high fatigue. This pattern is consistent with evidence from the maritime sector indicating that human fatigue is a major contributor to operational risk and is strongly associated with other factors involved in maritime accidents and incidents (Grandjean, 1979; Yang et al., 2023).

Regarding occupational stress, the measurements yielded a mean score of 16.8 (range: 0 - 42). Among the 54 respondents, 30 individuals (55.6%) were in the normal stress category, while 24 individuals (44.4%) experienced varying levels of occupational stress. The largest proportion fell into the extremely severe stress category (27.8%), followed by severe stress (7.4%), mild stress (5.6%), and moderate stress (3.7%). This distribution mirrors a study on stress management among Indonesian seafarers, which found that the majority of respondents experienced significant stress levels, driven primarily by social isolation, workload, and schedule uncertainty (Supangat & Marsudi, 2024).

Occupational stress among seafarers is recognized as a multidimensional phenomenon influenced by the physical work environment, job demands, interpersonal relationships onboard, and organizational factors, including shipping company policies (D'Souza, 2026). The General Adaptation Syndrome (GAS) explains that prolonged exposure to stressors elicits a non-specific physiological response that progresses through the stages of alarm, resistance, and exhaustion. When recovery is insufficient, sustained exposure to stressors gradually depletes the body's adaptive capacity, increasing vulnerability to adverse physical and psychological outcomes (Selye, 1956). Likewise, the transactional model of stress proposes that stress occurs when individuals appraise environmental demands as exceeding their available coping resources (Folkman, 2020).

In the present study, 27.8% of respondents experienced extremely severe occupational stress, suggesting that a considerable proportion of crew members may have been exposed to prolonged occupational demands that exceeded their adaptive capacity. This finding is consistent with the GAS framework, in which persistent exposure to stressors may lead to the exhaustion stage, and with the transactional model, which emphasizes the imbalance between perceived demands and coping resources as the basis of stress responses (Folkman, 2020; Selye, 1956). These findings highlight the importance of implementing organizational interventions, including psychological support services, appropriate work–rest schedules, and psychosocial risk management, to mitigate occupational stress and promote crew well-being (D'Souza, 2026; Folkman, 2020; Selye, 1956).

Implications and Recommendations for Stress Management

Persistent stress may contribute to physical and psychological fatigue physical and mental deterioration, ultimately culminating in work fatigue (Gaol, 2016). At the individual level, to prevent the escalation of occupational stress into the exhaustion phase, employees are advised to proactively employ emotion-focused coping mechanisms. On a practical level, employees should maintain discipline in allocating sufficient post-work rest periods to facilitate physical relaxation (Fitriani, 2021). Furthermore, engaging independently in brief meditation, light exercise, and mindfulness practices can help maintain work-life balance and enhance emotional self-control before emotional exhaustion sets in (Kharisma, 2025).

Conversely, organizational management holds the strategic responsibility to mitigate psychosocial hazards in the workplace to prevent stress from accumulating into emotional exhaustion among employees (Setiawan & Susanto, 2025). Companies are strongly recommended to provide dedicated relaxation areas equipped with calming amenities, such as audio-visual media, to aid employee recovery

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(Fitriani, 2021). Corporate support must be translated into tangible welfare policies, including coping skills training, mental health programs, and proportional workload distribution to preserve a healthy work-life balance (Setiawan & Susanto, 2025). The formal integration of mindfulness-based training in the workplace has also proven to be a highly effective interventional alternative for reducing employee occupational stress (Kharisma, 2025).

CONCLUSION

This study found a statistically significant association between occupational stress and work fatigue among small-vessel crew members at PT X. Crew members experiencing occupational stress had significantly higher odds of reporting work fatigue compared with those with normal stress levels (OR = 5.714; 95% CI: 1.571–20.781). Nearly half of the respondents reported high levels of work fatigue, while 44.4% experienced occupational stress, indicating a substantial burden of these conditions within the study population. These findings suggest that occupational stress is an important factor associated with work fatigue among small marine vessel crew members. Therefore, workplace interventions focused on reducing occupational stress, optimizing work schedules, and implementing fatigue management strategies may help reduce fatigue and improve occupational safety in maritime operations.

LIMITATIONS

This study has several limitations. First, the cross-sectional design prevents the establishment of temporal relationships or causal inferences between occupational stress and work fatigue. Second, the study was conducted in a single company and occupational setting involving small-vessel crew members supporting drilling and well intervention activities, which may limit the generalizability of the findings to other maritime workers or occupational contexts. Third, the relatively small sample size (n = 54) may have reduced the statistical power to detect associations.

RECOMMENDATIONS

Future research should incorporate a broader range of variables to better understand the multifactorial determinants of work fatigue among vessel crews, including psychosocial, individual, occupational, and environmental factors. This recommendation is supported by the finding that a considerable proportion of respondents experienced high levels of work fatigue despite reporting normal levels of occupational stress, suggesting that additional factors not examined in the present study may contribute to fatigue. Longitudinal studies with larger and more diverse samples are also recommended to clarify the temporal relationship between occupational stress and work fatigue and to identify other potential predictors of fatigue in maritime settings.

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