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Can Sleep Quality Be the Intervening Factor of Personality Data to Occupational Fatigue?

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Abstract

Fatigue during work among oil and gas employees can have dangerous effects on well-being, economics, safety, and health. This cross-sectional survey was conducted in July and August of 2022 at two national oil and gas companies located in Muara Jambi and Jambi City. A convenience sample of 116 respondents was selected in total. To address the study hypotheses, partial least squares-structured equation modelling (PLS-SEM) was employed. This study aims to determine the relationship between the risk of job weariness among Indonesian oil and gas workers in Jambi Province and the direct and indirect impacts of mental workload, sociodemographic characteristics, and sleep quality. Personality data has a significant and negative direct impact on occupational weariness at alpha 5% and with a path value of -0.203 (p-value: 0.047), corroborating the earlier hypothesis. For the second hypothesis, the path coefficient value of 0.462 (p-value: 0.000) clearly shows that sleep quality has an impact on occupational weariness. In order to improve sleep hygiene and address personality factors like age and length of employment, fatigue risk management strategies can be combined with those that are currently being used to control job tiredness.

Introduction

The Occupational fatigue is a subject studied in various research fields, such as cognitive neuroscience, exercise physiology, psychology, medical sciences, and public health (Skau *et al.*, 2021). Occupational fatigue is a change in the psychophysiological control system that regulates task performance, caused by preceding mental or physical efforts. Generally, fatigue is defined as a physiological state where a person is unable to perform a task or has decreased ability at a desired level of performance due to reduced mental and physical strength, sleep loss, circadian phase, and workload. In normal physiology, occupational fatigue may be weakness or fatigue from repeated exertion or a decreased response of cells, tissues, or organs after excessive stimulation, stress, or activity (Hirshkowitz, 2013). A common and potentially crippling symptom that affects the health-related quality of life of people with both acute and chronic medical problems is fatigue. Occupational fatigue was defined as “a distressing lack of energy or debilitating physical exhaustion that is not relieved by sleep or rest. Fatigue is the state of feeling very tired, weary, or sleepy resulting from insufficient sleep, prolonged mental or physical work, or extended periods of stress or anxiety, and repetitive tasks (Billones *et al.*, 2021). The feeling of fatigue is quite individual. Numerous interrelated aspects are

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evidently indicated by research. These have extremely diverse effects on various people. Other elements vary, such as the desire to work or avoid working overtime.

More experimental and longitudinal research is generally required to expand the body of information regarding the effects of exhaustion, poor sleep, and long work hours in the public safety field. Novel techniques for fatigue mitigation in several public safety areas have not been extensively evaluated in experimental studies. Employers' options for addressing fatigue as a risk to the health and safety of public safety workers are limited by this research gap. (Allison *et al*., 2022). Moreover, fatigue considerably decreased the participants' situational awareness. There was a significant relationship between participants' heart rates and how tired they felt. Fatigue considerably decreased the participants' ability to recognize hazards. Fatigue considerably decreased the participants' safety risk assessment (Ibrahim *et al*., 2023). Significant morbidity and mortality have been demonstrated to result from both chrono disruption and reduced sleep duration. There is substantial evidence linking fatigue, decreased cognitive function, and workplace accidents to higher mortality, metabolic and reproductive health complications, and some types of cancer. There is further proof that exhaustion causes persistent physical, neurological, gastrointestinal, and mental side effects (Lock *et al*., 2018).

Fatigue is a multidimensional construct associated with a range of physical, psychological, and mental factors, as well as workplace risk factors. The effect of fatigue can be catastrophic and seriously jeopardize workplace safety and health. Fatigue is a state of impairment that can negatively impact safety, productivity, quality, morale, compliance, profits, and more. The economic loss due to occupational fatigue in the US has been investigated (Ricci *et al*., 2007). Workers with fatigue cost employers $136.4 billion annually in health-related Lost Productive Time, an excess of $101.0 billion compared with workers without fatigue. Numerous well-publicized incidents, including Chernobyl, Exxon Valdez, and the Challenger Space Shuttle, have highlighted the role that fatigue plays. Furthermore, the oil and gas sector is inherently risky, and several widely reported investigations into significant incidents, including Piper Alpha (UK), Alexander Keilland (Norway), and Longford (Australia), have drawn the attention of management from both operating and contracting companies to safety concerns (Mearns, K., & Yule, 2009).

Additionally, there is a correlation between worker health, wellbeing, and performance and fatigue on a variety of dimensions, including burnout, cognitive exhaustion related to tasks and sleep, physical fatigue, emotional fatigue, and perceptual fatigue (Yung *et al*., 2020). Furthermore, several studies have shown that fatigue may increase the risk of cancer, mental health issues, and metabolic and cardiovascular health issues (Alroomi, A. S., & Mohamed, 2021). It may also cause mood swings, job stress, cognitive decline, sleep disturbance, and the incidence of MSDs (Heidarimoghadam *et al*., 2019), absenteeism from work (Sagherian *et al*., 2019) behaviour, performance, and climate(Gu, J., & Guo, 2022). Additionally, it may have an impact on reduced human performance levels, organizational productivity, and performance ability (Dahlan, A., & Widanarko, 2022). Hazardous conduct leading to fatalities among oil and gas employees, the likelihood of an incident, quality of life, well-being, and accident (Hinze *et al*., 2021). According to Benson *et al*. (2021), in addition to exhaustion, the oil and gas sector poses risks related to ergonomics (30%), physical hazards (26%), chemicals (23%), psychological hazards (18%), and biology (3%). Together with these other negative effects, fatigue also raises incident rates, medical expenses, employee turnover, forgetfulness, and a decline in alertness, reaction time, capacity for difficult jobs, and stress tolerance.

The result of the contemporary industrial civilization is fatigue (Caldwell *et al*., 2019). Workplace fatigue has emerged as a major problem, the leading cause of accidents and difficulties for Indonesian oil and gas employees. Primary risk factors clusters such as staff selection and training, monitoring and management, personal fatigue management, work pattern, staffing levels, shift work, circadian rhythm disruption, ultradian processes, health factors, mental and physical workload, sleep hygiene, sleep homeostasis, isolated work location, loneliness, lack of family support, education, BMI, long working duration, roster pattern, length of shift, timing of shift, insufficient recovery time between shifts, type of work, and insufficient rest breaks are some of the factors that contribute to occupational fatigue in the oil and gas and petrochemical industries. Extraneous variables such as journey duration, social life, family obligations, and the number of children (Kang *et al*., 2021; Kusmawan *et al*., 2024; Ghasemi *et al*., 2019; Sinagabariang & Kurniawidjaja, 2024).

There are currently few association studies and mechanisms explaining how sociodemographic factors, including age, length of employment, Body Mass Index (BMI), sleep quality, and mental workload, affect job tiredness in oil and gas personnel. Additionally, by identifying the most important variables, fatigue risk management techniques should be used to mitigate and lower short- and long-term health and safety risks in oil and gas workers. The purpose of this study is to ascertain the association between the risk of work fatigue in oil and gas workers in Jambi Province, Indonesia, and the direct and indirect effects of sociodemographic factors, mental workload, and sleep quality.

Method

Two national oil and gas firms in Muara Jambi and Jambi City, Jambi Province, Indonesia, were the sites of this cross-sectional study, which was carried out in July and August of 2022. Convenience sampling was used to pick 116 respondents overall, all of whom were willing to work in the oil and gas industry. The Research Ethics Commission, Faculty of Public Health, UNAND University accepted this study (Ethic Number:19/UN16.12/KEP-FKM/2022). Respondents signed an informed consent form before data collection, and their identities and confidentiality were ensured. The research instrument used the occupational fatigue (KUPK1) questionnaire, Sleep Quality (PSQI), and Mental Workload (NASA-TLX). This tool, which measured mental workload, was reliable and extensively utilized (Lund *et al*., 2021;Tubbs-Cooley *et al*., 2018; Mouzé-Amady *et al*., 2013).

To summarize the demographic data, descriptive statistics were employed. Partial Least Squares-Structural Equation Modeling (PLS-SEM) was the method used to address the study's hypotheses. On the recommendation of Götz *et al*. (2009), partial least squares (PLS-SEM) is taken into consideration. In their view, PLS analysis is a reliable measurement technique that can be used with small sample sizes and does not necessitate assumptions about the data's measurement scale. This study intends to ascertain the effects of mental workload, sleep quality, and sociodemographic data (SD) on occupational fatigue (OF) with a particular focus on oil and gas employees. To estimate complex models with several indicators and structural routes without making distribution assumptions about the data, the SEM-PLS method is highly appealing to a large number of researchers (Hair Jr *et al*., 2021). Furthermore, applicable to smaller sample sets, in which case the coefficient values according to Hair Jr *et al*. (2021), at the 5% significance level, 69 samples provide the minimal path likely to be significant, which is between 0.21 and 0.3.116 workers in Indonesia's oil and gas industrial sector, specifically in the upstream segment, provided replies for the study.

The data analysis process employs selected statistical approaches, and the questionnaire follows a Likert scale format. The process of measuring the reflective model was called outer model analysis, and it involved multiple steps. These comprised evaluating the composite reliability, convergent and discriminant validity, and indicator loadings. Item loadings were restricted to values greater than 0.6. Higher than 0.6 Cronbach's alpha values were seen as suggestive of a reliable internal consistency. Acceptable convergent validity was also shown by AVE values $\geq$ 0.05, while HTMT values $<$ 0.85 were used to determine the results of the discriminant validity test. Two measures were employed to assess the inner model analysis: the coefficient of determination (R2) and predictive relevance (Q2). When the R2 value was greater than zero, it was considered significant; values of

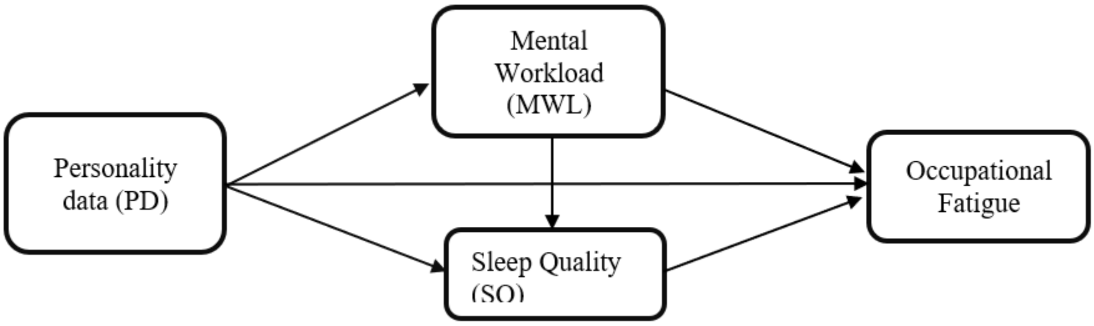

Figure 1. SEM-PLS conceptual framework

0.75, 0.50, and 0.25 were considered moderate, substantial, and weak, respectively. The direct association between mental workload, sleep quality, and occupational weariness was discovered by analyzing the bootstrap t-test probability value (Hair *et al.*, 2019).

H.1 Personality data has a direct effect on occupational fatigue, H.2 Sleep quality is an intervening factor of the effect of personality data on occupational fatigue, and H.3 Mental workload is an intervening factor of the effect of personality data on occupational fatigue

Result and Discussion

The distribution of respondents in Table 2 indicates that the percentage of job experience falls between 27 and 30 percent in all categories. The age group of 45 to 59 years old accounts for the largest number of workers (51.7%, or 60 individuals), followed by the 25–44 years age group, which has 50 individuals (43.1%). Ninety-three out of the 116 respondents, or 80.2% of the total, had an ideal (normal) BMI

Table 1. Distribution of Respondent Characteristics in PT X (Persero)

Characteristics	**Category**	**n**	**%**
Working Periods/WP (year)	≤ 9.5	29	25.0
	9.25 - 17	30	25.9
	17.01 - 24	30	25.9
	> 24	27	23.3
Age (year)	< 15	0	0
	15 - 24	6	5.2
	25 - 44	50	43.1
	45 - 59	60	51.7
Body Mass Index	< 18.5	0	0
	18.5 - 24.9	93	80.2
	25 - 29.9	12	10.3
	≥ 30	11	9.5
Occupational Fatigue	Low	52	44.8
	Hight	64	55.2

Source: Primary Data Analysis, 2022

Table 2. Reflective Measurement and Structural Model

Latent Variable	Indicator	Reliability		Validity	VIF		R2	R2-adj
		Outer loading	Cronbach's alpha	AVE	Outer	Inner		
Personality Data	WP	0.947	0.779	0.811	1.686	1.014	0.244	0.224
	Age	0.852			1.686			
Mental Workload	N13	1.00	1.00	1.00	1.000'	1.015		
Sleep Quality	P1	0.807	0.383	0.618	1.059	1.012		
	P8	0.765			1.059			
Occupational Fatigue	K.6	0.72	0.837	0.505	1.791	-		
	K.7	0.641			1.454			
	K.12	0.703			1.594			
	K.13	0.762			1.822			
	K.15	0.722			1.659			
	K.16	0.736			1.870			
	K.17	0.686			1.481			

Table 3. Discriminant Validity

Variables	Mental Workload	Occupational fatigue	PD	Sleep Quality
Mental Workload				
Occupational Fatigue	0.134			
Personality Data	0.091	0.242		
Sleep Quality	0.143	0.787	0.191	

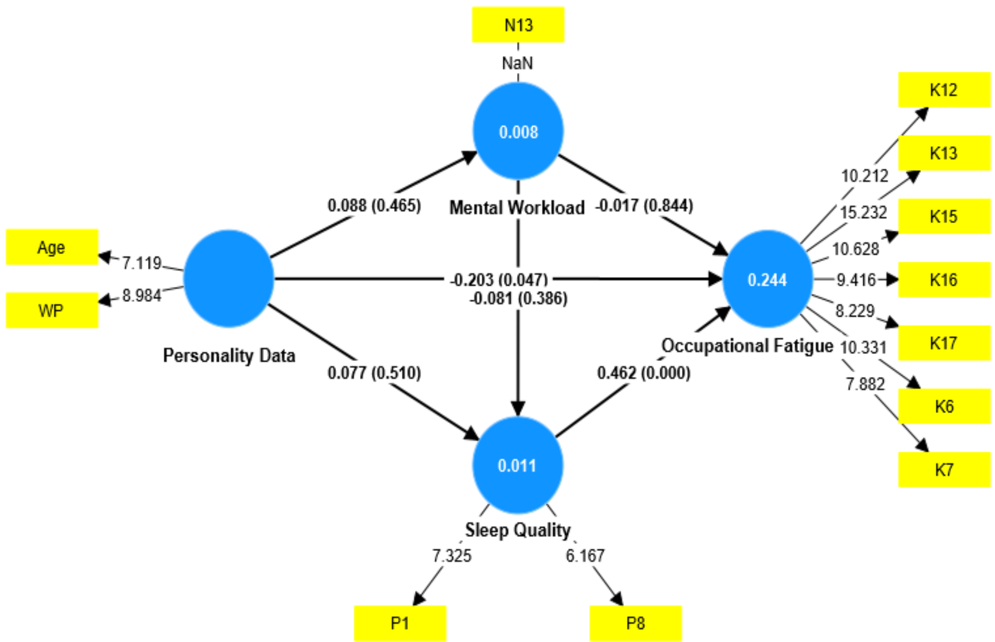

Figure 2. Conceptual Model SEM-PLS

Table 4. Hypothesis Test Results

Path		Coeff	T-stat	P-value
From	**To**			
Personality Data	Mental Workload	0.088	0.730	0.465
Personality Data	Sleep Quality	0.077	0.659	0.510
Personality Data	**Occupational Fatigue**	**-0.203**	**1.990**	**0.047***
Mental Workload	Sleep Quality	-0.081	0.866	0.386
Mental Workload	Occupational Fatigue	-0.017	0.196	0.844
Sleep Quality	**Occupational Fatigue**	**0.462**	**5.763**	**0.000***

Table 3 presents the findings, which indicate that the overall model goodness criteria in both the reflective measurement model and the structural model have been satisfied. In terms of dependability, each indicator's loading factor value falls between 0.641 and 0.641. When the Heterotrait – Monotrait correlation value in Table 4 is less than 0.9, and the overall AVE value is greater than 0.5, the model can also be considered valid.

Table 5 provides evidence that, at alpha 5% and with a path value of -0.203 (p-value: 0.047), personality data directly influences occupational fatigue in a substantial and negative manner, supporting the first hypothesis. Similarly, the path coefficient value of 0.462 (p-value: 0.000) for the second hypothesis indicates that occupational fatigue is equivocally influenced by sleep quality. In this study, the third hypothesis was not proven, namely, mental workload as a mediating factor in the relationship between the influence of personality data on work fatigue, which means that the occurrence of work fatigue in oil and gas workers in Jambi Province occurs directly due to personal data factors, namely, length of service and age. This research is different from. In the latent variables of personality data, indicators of age and length of service have a negative influence on work fatigue. This means that work experience and age are inversely related to work fatigue. The longer the working period, the lower the influence on work fatigue among oil and gas workers in Jambi Province. In this study, productive age workers between 25 and 44 years of age (43.1%) felt greater work fatigue than those in the 45 to 59 years age range. Numerous research shows a confusing and contradictory link between occupational fatigue and aging. However, a few studies have demonstrated a strong positive correlation between age and occupational fatigue. One intriguing finding of this research is that, as one ages, work-related weariness decreases and vice versa. It's probable that workers older than 59 years old have greater abilities and adaptation, along with a somewhat lower mental and physical workload than this group of workers.

Age is one of the factors that affects an individual's work ability. The hourly energy consumption on the condition of working muscles for each person is different, one of which is the age factor. Someone's age factor will affect the basal metabolism, which will decrease, and the individual will easily experience fatigue. Growing older was linked to worse recovery and higher levels of both acute and chronic fatigue. Every aspect of work-related exhaustion is impacted by aging, including changes in muscle strength (Giuliani *et al*., 2020).

Overall, muscle mass is determined by the equilibrium between the synthesis and breakdown of proteins, and both processes are influenced by a variety of variables, including hormonal balance, diet, physical activity, and illness (Frontera, W. R., & Ochala, 2015). This three-year longitudinal study of older persons revealed that while deteriorating physical performance and muscle mass lead to a loss in quality of life, diminishing strength, power, and muscle mass are independent contributing variables to an increased fear of falling. Our results highlight how crucial it is to maintain muscular fitness as one ages. Declining physical performance, strength, power, and muscle mass all independently raise FoF in older persons with and without mobility restrictions, whereas declining physical performance and muscle mass also lower QoL. These results offer more justification for creating therapies to enhance the health of ageing muscles (Trombetti *et al*., 2016).

A significant decline in maximal voluntary isometric contraction occurs with aging due to neural activation of agonist muscles during knee extensors (Wu *et al*., 2016). It is commonly accepted that the muscles of the elderly contract with less force, relax more slowly, and show a downward shift in force-velocity correlations. Contractile velocity has a major impact on skeletal muscle's age-related fatigue resistance (Callahan, D. M., & Kent-Braun, 2011). As many as 60 workers, or 51.7%, are between the ages of 45 and 59. This distribution indicates that half of the workforce is in the no-longer-young age range.

There is less of a direct impact on work tiredness from the longer work periods. The work period is the amount of time an employee dedicates their strength to a certain organization, where the workforce can produce work that meets expectations based on aptitude, skills, and specific talents needed to complete the task at hand. Workers who have worked for a long time will typically feel more at ease in the firm since they have had enough time to acclimate to their surroundings and get along with other employees. Fatigue is a very personal sensation. Numerous interrelated aspects are evidently indicated by research. These have extremely diverse effects on various people. Other elements vary, such as the desire to work or avoid working overtime. P1 and P8, which are question indicators that gauge respondents' typical bedtime (P1) and an evaluation of their overall sleep quality indicators (P8), are indicators on the sleep quality variable (PSQI) that have a little favourable impact on work tiredness. There is a higher chance of experiencing occupational fatigue among employees who start sleeping later in the evening. Similarly, for indication (P8), the likelihood of occupational fatigue increases with a worker's opinion of their sleep quality. Sleep disorders are a problem for some employees in the oil and gas industry. This problem may arise from shift work or work patterns, as well as from working in an atmosphere that demands a high level of focus and danger.

The greatest way to combat occupational fatigue is to get enough sleep (Mehta *et al*., 2019). This is consistent with current research, which states that an increased risk factor for fatigue results from reduced rest duration and poor sleep quality. Fatigue was significantly impacted by the quality of sleep at 95% confidence interval. One theory was that employees were less likely to feel exhausted when they slept well. It has been determined that maintaining proper sleep hygiene is crucial for increasing employee productivity.

Sleep improves a wide range of mental processes in the brain, including memory, learning, and rational decision-making. Sleep is a kind gift to our mental health; it resets the emotional circuits in our brains, enabling us to face the social and psychological obstacles of the next day with poise and calm. Sleep replenishes the immune system's stockpiles downstairs in the body, aiding in the fight against cancer, averting infection, and fending off a host of ailments. Sleep adjusts the insulin and glucose levels in the bloodstream to restore the body's metabolic equilibrium. Our appetite is further controlled by sleep, which promotes healthy eating habits rather than hasty impulses when it comes to weight control. A healthy gut microbiota, which is where we know so much about our nutritional health starts, is maintained by getting enough sleep

In young, healthy people, the gut microbiome composition was linked to self-reported sleep quality. Positive correlations were found between microbial diversity, F/B ratio, and butyrate-producing taxa and good self-reported sleep quality. In the genus *Prevotella,* poor self-reported sleep quality was linked (Grosicki, G. J., et.al 2020).

The growing prevalence of sleep deprivation, its effects, and the pressing need to research this worldwide public health concern are all brought to light as we wrap up our review. Several diseases that trigger pro-inflammatory pathways and lead to early death are linked to sleep deprivation. Poor sleep, irregular body rhythms, and ill health are all strongly suggested to be caused by the gut bacteria (Matenchuk *et al*., 2020). Due to its cross-sectional design, this study has some drawbacks common to this kind of research. One reason is that it is challenging to prove causation since, of course, a long-term and experimental study is required to draw a definitive judgment about it (Allison *et al.*, 2022). In addition, other factors, including living quality, employees' psychological health, and the distance commuted from home to work, need to be looked (Kusmawan *et al.*, 2021).

Conclusion

In conclusion, the quality of sleep has a mediating role in the association between personality traits and occupational tiredness. There's no denying that occupational fatigue is influenced by the quality of sleep. There is little doubt that the quality of sleep affects occupational fatigue. It is possible to combine fatigue risk management strategies with those currently in use to control work weariness in a way that enhances sleep hygiene and addresses personality factors like age and term of employment.

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