

## Original Research Report

### FACTORS THAT CAUSE WORK FATIGUE AMONG SHIPYARD WORKERS

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#### ABSTRACT

Work fatigue remains a prevalent issue among workers in shipyards, leading to detrimental effects on physical well-being, including a decline in body resistance and productivity. The objective of this study was to analyze the relationship between age, nutritional status, working period, physical workload, noise, and lighting with fatigue levels among hull construction workers. This observational study used a cross-sectional approach with a total population of 112 individuals working in the production line of the Warship Division of a shipbuilding company. The sample size in this study was determined using stratified random sampling, resulting in 53 samples. Proportionate stratified random sampling was then employed to determine the sample size for each subgroup of the population. The research data were analyzed using the Spearman correlation test ( $p < 0.005$ ). This study found a significant relationship between work fatigue and nutritional status ( $p = 0.000$ ), with a moderately positive relationship ( $r = 0.511$ ). Additionally, there was a significant relationship between work fatigue and physical workload ( $p = 0.000$ ), with a moderately positive relationship ( $r = 0.531$ ). Noise and work fatigue showed a significant relationship ( $p = 0.010$ ), with a weak positive relationship ( $r = 0.353$ ). Lighting and work fatigue showed a significant relationship as well ( $p = 0.000$ ), but with a moderately negative relationship ( $r = -0.524$ ). On the other hand, work fatigue did not exhibit any significant relationship with age ( $p = 0.129$ ) or working period ( $p = 0.651$ ). This study found a relationship between work fatigue and numerous factors, including nutritional status, physical workload, noise, and lighting. However, age and working period were not related to work fatigue. Thus, it is recommended that companies align job requirements with employees' work capacity and conduct regular assessments of noise and lighting conditions to mitigate work-related fatigue.

**Keywords:** Nutritional status; physical workload; noise; work fatigue; public health

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#### Highlights:

1. The focus of this study was on the underlying factors of fatigue among shipyard workers, an area that necessitates further research to attain ideal standards in occupational health and safety.
2. This study can provide companies with material to use when counseling workers on the importance of a healthy nutritional intake in preventing fatigue.

## INTRODUCTION

All workers have the right to assurances regarding their health and safety at work, according to the Law of the Republic of Indonesia Number 13 of 2003 Concerning Manpower. Therefore, it is the responsibility of the company to establish and implement an occupational health and safety program to protect workers from potential hazards during the course of their duties. The employment

report of the Social Security Implementation Agency documented workplace accidents in Indonesia that have been increasing in recent years. A total of 123,041 work-related accidents were reported in 2017, while an increase to 173,105 was recorded in 2018. The agency handles an annual average of 130,000 work-related accidents, ranging from minor mishaps to fatalities (Monalisa et al. 2022).

One of the most unsafe conditions for workers is fatigue. Work fatigue is a physical and psychological condition that reduces an individual's workability and resistance to activities. It can harm workers by causing accidents, injuries, and decreased work productivity (Suma'mur 2014). According to the report of the [International Labour Organization \(2018\)](#), work fatigue was responsible for the deaths of nearly two million workers. The results from their survey of 58,118 samples revealed that approximately 32.8% of workers, or 18,828 individuals, had experienced work fatigue. The findings of a previous study provided additional evidence for the prevalence of work fatigue. It was found that a total of 23–40% of workers experienced high levels of work fatigue (Tung & Hsiung 2021).

Work fatigue can affect workers in any sector, including those working in shipyards. There are approximately 250 shipyards in Indonesia, each employing a diverse range of workers. According to a previous study, 56.5% of workers suffer from work fatigue. Workers who endure such fatigue are more at risk of experiencing work-related accidents. In addition, a separate study revealed comparable findings, showing that 56.2% of shipyard workers suffered from work fatigue (Pratiwi 2019).

Work fatigue may arise due to internal factors including but not limited to age, nutritional status, years of service, and gender. However, in addition to internal factors, work fatigue may also result from external factors, such as the physical work environment, workload, length of working time, and monotony (Suma'mur 2014). A study conducted by Larasati & Puspitasari (2019) showed that a significant proportion of workers (82.8%) who had a relatively heavy physical workload were found to experience high levels of work fatigue. The physical work environment, including factors such as lighting and noise, can also contribute to work fatigue.

The workday of shipyard workers in Indonesia starts early at 7.30 a.m. and concludes at 4.30 p.m. Most of the workers' activities aboard the ship take place while the ship is still in the construction process. Consequently, the workers rely solely on substandard streetlamps for lighting. In addition, the workers are frequently exposed to noise generated from the tools they use in their work, such as hammers, grinders, rotary impact drills, welding machines, diesel generators, and blowers. They also use more muscular energy to complete their work (Kaunang et al. 2019). The aforementioned working conditions sparked the authors' interest regarding work fatigue among shipyard workers. Therefore, this study aimed to analyze the factors that contribute to work fatigue among shipyard workers, particularly in the warship division of a shipbuilding company in Surabaya, Indonesia, where there were

four ship projects in progress at the time of this research.

## MATERIALS AND METHODS

This was an analytical observational study in which data were collected solely from research subjects without providing any intervention. This study used a cross-sectional design because the research was conducted at a certain time (Spector 2019). The ethical approval for this study was issued by the Health Research Ethics Committee of the Faculty of Dental Medicine, Universitas Airlangga, Surabaya, Indonesia (No. 032/HRECC.FODM/2022 on 26/1/2022). The research was conducted in March 2022 at the warship division of a shipbuilding company in Surabaya, Indonesia.

This study used stratified random sampling to determine the required research sample size. A total of 53 samples were acquired according to the sampling technique. Afterwards, this study used proportionate stratified random sampling to determine the sample size for each of the three workshops, i.e., the Hull Construction Workshop, the Machinery Outfitting Workshop, and the Hull Outfitting Workshop (Etikan 2017). The obtained samples were 21 workers from the Hull Construction Workshop, 20 workers from the Machinery Outfitting Workshop, and 12 workers from the Hull Outfitting Workshop. The variables analyzed in this study were independent and dependent variables. The independent variables consisted of age, nutritional status, years of service, physical workload, noise exposure, and lighting. Meanwhile, work fatigue served as the dependent variable.

The nutritional status variable was determined by initially measuring the workers' weight and height using a digital scale and a microtome, respectively. Afterwards, the body mass index (BMI) formula was calculated to determine the nutritional status. The measurement of physical workload was carried out using the percentage of cardiovascular load (%CVL) method by recording the workers' pulse. The measurement of work fatigue was conducted by using a reaction timer on a sample of 53 shipyard workers (Halsen 2014). All data were statistically analyzed using IBM SPSS Statistics for Windows version 25.0 (IBM Corp., Armonk, N.Y., USA). The technique used for data analysis was Spearman's correlation coefficient ( $p < 0.05$ ). The analysis assessed the monotonic function, a function that is in accordance with the arbitrary, to describe the relationship between two variables without making any assumptions regarding the frequency distribution of the variables being examined (Yasril & Fatma 2021).

## RESULTS

The present study included a sample of 53 individuals who were employed as shipyard workers. According to the data presented in Table 1, it is evident that the majority of workers are within the age group of 35 years, which includes a total of 27 individuals (51%). Most of the workers had a moderate degree of underweight in terms of their nutritional status, as shown by a total of 15 workers (28.3%). In addition, a substantial proportion of the workers, comprising 33 individuals (62.3%), had been working for a period of 6–10 years.

Table 1. Distribution of characteristics of the shipyard workers (n=53).

Variables	Categories	n	%
Age	35 years old	27	51.0
	36–50 years old	21	39.6
	>50 years old	5	9.4
Nutritional status	Severely underweight	9	17.0
	Moderately underweight	10	18.9
	Normal	12	22.6
	Overweight	15	28.3
Obese		7	13.2
Working period	5 years	8	15.1
	6–10 years	33	62.3
	>10 years	12	22.6
Physical workload	Light	5	9.4
	Medium	15	28.3
	Slightly heavy	23	43.4
	Heavy	7	13.2
	Very heavy	3	5.7
Noise	<PEL	14	26.4
	>PEL	39	73.6
Lighting	Standard	33	62.3
	Substandard	20	37.7
Work fatigue	Normal	30	56.6
	Mild	22	41.5
	Moderate	1	1.9

PEL: Permissible exposure limit.

This study revealed that nearly half of the workers, specifically 23 individuals (43.4%), exerted themselves in physical tasks that fell within the slightly heavy workload category. Regarding the working environment in the shipyard, the analysis focused on two factors contributing to work fatigue, i.e., noise and lighting conditions. It was found that a majority of workers performed their tasks in areas where noise levels exceeded the permissible exposure limit, encompassing a total of 39 individuals (73.6%). Moreover, a large portion of workers carried out their tasks with substandard lighting, including 33 individuals (62.3%). With regard to the aforementioned factors pertaining to the workers and their working environment, it was

observed that they exhibited varying degrees of work fatigue. Nevertheless, a significant proportion of workers experienced work fatigue that was still within the normal category, with as many as 30 workers (56.6%).

The data on the workers' characteristics were then analyzed by cross-tabulation to examine the relationship between work fatigue and several factors, including age, nutritional status, working period, physical workload, noise, and lighting (Table 2). Although work fatigue in the normal category was the most prevalent, more than half of workers aged 35 exhibited mild work fatigue. A total of 14 workers in the age group of 35 years old experienced mild work fatigue, which accounted for 51.9% of the total sample in this group. However, the Spearman correlation test yielded a p-value of 0.129, suggesting a lack of a significant relationship between age and work fatigue among shipyard workers.

A substantial majority of workers with an overweight status had complaints of mild work fatigue, with as many as 10 individuals (66.7%). The Spearman correlation test analysis yielded a p-value of 0.000, showing a statistically significant relationship between nutritional status and work fatigue among shipyard workers. Additionally, the Spearman correlation analysis produced a correlation coefficient of 0.511, indicating a moderately positive or unidirectional relationship between these two variables.

The majority of workers with a working period ranging from 6 to 10 years stated having mild work fatigue. This was observed in 17 individuals, accounting for 51.5% of the subgroup size. The results of the Spearman correlation test revealed a p-value of 0.651, indicating the absence of a significant relationship between the working period and work fatigue experienced by the shipyard workers.

There was a concern that work fatigue was caused by an intense physical workload. The results of this study showed that the majority of workers had a slightly heavy physical workload, accompanied by a relatively mild degree of work fatigue. This was demonstrated by a total of 16 individuals, accounting for 69.6% of the subgroup size. The Spearman correlation test found a p-value of 0.000, indicating a statistically significant relationship between physical workload and work fatigue among shipyard workers. In addition, the obtained correlation coefficient of 0.531 indicated a moderate level of relationship between the two variables.

Table 2. Relationship between work fatigue and its underlying factors among the shipyard workers (n=53).

Variables	Categories	Work fatigue						p
		Normal		Mild		Moderate		
		n	%	n	%	n	%	
Age	35 years old	13	48.1	14	51.9	0	0	0.129
	36–50 years old	12	57.1	8	38.1	1	4.8	
	>50 years old	5	100	0	0	0	0	
Total		30	56.6	22	41.5	1	1.9	
Nutritional status	Severely underweight	7	77.8	2	22.2	0	0	0.000
	Moderately underweight	9	90.0	1	10.0	0	0	
	Normal	8	66.7	4	33.3	0	0	
	Overweight	5	33.3	10	66.7	0	0	
	Obese	1	14.3	5	71.4	1	14.3	
Total		30	56.6	22	41.5	1	1.9	
Working period	5 years	7	87.5	1	12.5	0	0	0.651
	6–10 years	15	45.5	17	51.5	1	3	
	>10 years	8	66.7	4	33.3	0	0	
Total		30	56.6	22	41.5	1	1.9	
Physical workload	Light	5	100	0	0	0	0	0.000
	Medium	14	93.3	1	6.7	0	0	
	Slightly heavy	7	30.4	16	69.6	0	0	
	Heavy	3	42.9	4	57.1	0	0	
	Very heavy	1	33.3	1	33.3	1	33.3	
Total		30	56.6	22	41.5	1	1.9	
Noise	<PEL	12	85.7	2	14.3	0	0	0.010
	>PEL	18	46.1	20	51.3	1	2.6	
Total		30	56.6	22	41.5	1	1.9	
Lighting	Standard	12	36.4	20	60.6	1	3	0.010
	Substandard	18	90.0	2	10.0	0	0	
Total		30	56.6	22	41.5	1	1.9	

A substantial number of workers employed in areas that had excessive noise levels beyond the permissible exposure limit experienced mild work fatigue, with as many as 20 individuals (51.3%). The Spearman correlation test resulted in a p-value of 0.010. Hence, there was a significant relationship between noise and work fatigue among shipyard workers. Furthermore, the obtained correlation coefficient of 0.353 indicated that the two variables had a weak positive relationship.

Most of the workers (60.6%) who carried out their activities in areas with inadequate lighting experienced mild work fatigue. The results of the Spearman correlation test showed a p-value of 0.000. Therefore, a significant relationship was observed between lighting and work fatigue experienced by shipyard workers. The obtained correlation coefficient of -0.524 showed a moderate degree of relationship between lighting and work fatigue. It was implied that higher lighting intensity was necessary to lower the level of work fatigue.

## DISCUSSION

Work fatigue is a condition characterized by a decline in work capacity and physical strength, resulting in a diminished ability to sustain work performance. Work fatigue also includes declined physical exertion, feelings of exhaustion, decreased motivation, and poor work productivity (Suma'mur

2014). According to the findings of this study, it was evident that the majority of the shipyard workers did not have work fatigue. However, this might be due to the relatively low work intensity observed throughout the period of the research, particularly in the Hull Construction Workshop and the Electric Outfitting and Interior Workshop.

The prevalence of mild work fatigue was mostly observed among workers in the Machinery Outfitting Workshop and the Hull Outfitting Workshop. This was attributed to the time constraints imposed on the workshops to finish the targets within a specified timeframe during the period of this study, resulting in an intense workload for the workers. The workshops frequently failed to achieve their targets, requiring the workers to subsequently revise their work. In addition, workers in the Machinery Outfitting Workshop and the Hull Outfitting Workshop often experience occupational accidents, including minor injuries such as scratches and bumps. Failure to immediately manage work fatigue can lead to a decline in work motivation and performance, as well as an increased likelihood of making mistakes, decreased productivity, job-related injuries, and work accidents (Tarwaka 2019).

### Relationship between age and work fatigue among shipyard workers

Among the 53 workers examined in this study, 27 (51.0%) were 35 years old, placing them within the



age range that is considered productive. These workers have higher productivity compared to older workers. This is due to the fact that as workers age, their physical condition deteriorates and their mobility becomes limited (Aprilyanti 2017). Age is an individual factor that may influence the level of work fatigue. With increasing age, muscle strength and functional capacity will diminish, making workers more susceptible to fatigue (Suma'mur 2014). However, the findings of this study revealed that there was no relationship between age and work fatigue among shipyard workers. This was in line with previous research that concluded there was no relationship between the two variables in the context of gold mining production workers (Wahyuni & Indriyani 2019). In addition, no statistically significant relationship was found between age and work fatigue in a separate study. It was determined that there was no relationship between age and fatigue among ceramic production workers (Juliana et al. 2018).

The majority of subjects in this study who reported mild fatigue were 35-year-old workers. The young workers were more likely to experience mild work fatigue because a lot of workers over the age of 35 acted as group leaders and therefore monitored work more. Conversely, the 35-year-old workers were assigned a greater number of duties, while the group leaders verified the outcomes. The research findings of Dewi et al. (2019) showed that younger workers are more prone to experiencing work fatigue. Younger workers are generally perceived to have superior physical conditions than their older colleagues, leading to increased workloads and extended work hours.

#### **Relationship between nutritional status and work fatigue among shipyard workers**

As many as 15 individuals (28.3%) among 53 workers were overweight in terms of their nutritional status. The measurement of the workers' nutritional status in this study was conducted using BMI, which was determined by their height and weight (Suma'mur 2014). In the meantime, the body requires balanced nutrition to support physical growth, brain development, and workability. The role of nutrition is to support workers in their activities by providing the necessary energy to mitigate the risk of work fatigue. Therefore, healthy nutritional status can prevent fatigue and improve the overall health of workers (Garedja et al. 2017, Natizatun et al. 2018).

The findings of this study revealed a statistically significant relationship between nutritional status and work fatigue. This observation aligns with other studies that have demonstrated a relationship between nutritional status and work fatigue (Safira

et al. 2020). The studies similarly identified a relationship between the two variables. Nevertheless, the analysis revealed that the relationship between the variables was of moderate significance (Amin et al. 2019).

In this study, most of the workers who were overweight experienced mild fatigue. This was due to their preference for buying meals from outside merchants rather than consuming the food provided by the company. In addition, it is worth noting that there was a lack of guidance from the company on the importance of maintaining a balanced diet as a means to prevent work fatigue. Excess fat may limit the ability of the workers' muscles and bones to perform physical tasks. The accumulation of excess fat within the vital organs of the body can lead to a decline in organ functionality and an inability to effectively meet occupational needs, hence causing workers to suffer from work fatigue (Tarwaka 2019).

#### **Relationship between working period and work fatigue among shipyard workers**

The working period refers to the duration during which a worker has been engaged in carrying out their duties within an annual period. The factor of working period in this study was the length of time the workers had been performing their duties, specifically up until the research was conducted. The majority of the workers had a working period ranging from 6 to 10 years, accounting for 33 individuals, or 62.3% of the total sample. Workers with a long working period are less likely to experience fatigue due to their ability to adapt to their jobs and work environment, as well as their level of experience in doing their tasks (Suma'mur 2014).

In this study, there was no significant relationship between working period and work fatigue among shipyard workers. This finding is consistent with previous research, which indicated a lack of relationship between working period and fatigue (Yamaula et al. 2021). In a separate study, a comparable result was discovered. The research showed no significant relationship between working period and work fatigue (Malik et al. 2021).

A large number of young workers have work experience over five years, primarily due to their participation in employment after graduating from high school. Therefore, even though they are relatively young, they are included in the category of individuals with a long working period. While previous research suggested that individuals with a long working period are less likely to experience fatigue, a separate study presented contrasting findings. Workers with long working periods may

potentially experience higher levels of fatigue as a result of the monotonous nature of their jobs (Asriyani & Karimuna 2017).

### **Relationship between physical workload and work fatigue among shipyard workers**

The physical workload serves as a representation of the requirement that the company imposes, requiring the use of physical energy to complete the assigned tasks. All physical activities carried out by workers are considered workload. Physical workload can affect bodily organs, including changes in heart rate (Tarwaka 2019). Workers may have a heavy physical workload due to the daily requirement of achieving targets on the same day. Shipyard workers in this study mostly had a slightly heavy physical workload, as shown by 23 individuals (43.4%). The findings of this study indicated a statistically significant relationship between physical workload and work fatigue. The workers who had a slightly heavy physical workload were primarily employed in the Machinery Outfitting Workshop and Hull Outfitting Workshop. This might be attributed to the inherent demands of the assigned tasks, which must be completed as part of specified targets. Additionally, the need for repeated revisions due to suboptimal work quality further contributed to the physical workload. The operation of equipment and the handling of materials required the workers' extra energy. On a daily basis, workers were assigned a certain target that needed to be accomplished within the same day. In instances where the assigned tasks were uncompleted, workers were obligated to work overtime, resulting in an increase in the physical workload.

The research conducted by Kaunang et al. (2019) yielded comparable results to the present study. A relationship was discovered between physical workload and work fatigue. This study is consistent with the findings of Pua et al. (2020), who found a moderately positive correlation between physical workload and work fatigue. The physical workload may increase when tasks are carried out manually. Shipyard workers are classified as manual laborers due to their role as operators of various equipment, including grinding, hammering, welding, and cutting. The physical workload placed on workers can increase when they lack optimal nutrition and are exposed to high noise levels and inadequate lighting conditions (Sakti 2021). When workers' workload surpasses their capacity, it leads to a decline in muscle strength for contraction. This results in muscle weakness and subsequently causes work fatigue (Pujiastuti et al. 2021).

### **Relationship between noise and work fatigue among shipyard workers**

Excessive noise in the workplace can have detrimental effects on workers. It may lead to many issues, such as communication problems, compromised health, decreased concentration, and increased fatigue (Suma'mur, 2014). The current study conducted measurements of noise levels at ten specific locations throughout four different ships. The results revealed that eight of these measurement points exceeded the permissible exposure limit, while the other two locations did not surpass the limit. The permissible exposure limit for noise was set at 85 dBA, with a daily exposure duration of eight hours (Ministry of Manpower of Republic Indonesia 2018). In these ten locations, equipment was the main source of noise. These included hammers, rotary impact drills, welding machines, diesel generators, cable cutters, air conditioners, and blowers (Sudirman Central Business District 2017).

The company in which this study was conducted had never measured noise levels on the ship, despite the majority of workers undertaking their duties aboard. Some workers were exposed to noise exceeding the permissible exposure limit without using personal protective equipment, such as ear plugs or ear muffs, indicating a lack of initiative in reducing noise exposure. Workers who are exposed to noise levels over 85 dBA are required to wear personal protective equipment to prevent their exposure from exceeding the permissible exposure limit. In addition to the use of personal protective equipment, work rotation may help minimize high noise exposure that causes health problems (Suma'mur 2014). In this study, it was found that there was a statistically significant relationship between noise and work fatigue among shipyard workers. This finding is in line with prior research that has reported a weak relationship between noise and work fatigue (Rahmawati & Tualeka, 2019). The impact of noise on workers' performance and well-being has been investigated as an essential work environment factor. A separate study resulted in the finding of a positive relationship between noise and work fatigue (Pratiwi 2019, Kurniawan et al. 2020).

Silencers were not provided for the machinery used by the workers in this study. Due to the narrow space of the ships, the intensity of the noise escalated. Excessive noise in work environments has been observed to have detrimental effects on workers' concentration and performance. It may lead the workers to become careless and make mistakes, indicating a symptom of work fatigue. The central nervous system is made up of an activation system, also known as the drive system, and an inhibition system. These two systems function in an alternating manner to regulate various processes within the

brain. In environments with a high level of noise, the thalamus exerts a stimulating effect on the inhibition system, hence strengthening its activity (Suma'mur 2014). Consequently, workers exposed to such conditions may exhibit symptoms of body weakness and work fatigue.

### **Relationship between lighting and work fatigue among shipyard workers**

The provision of adequate lighting is an important factor for workers since it allows them to clearly see objects with less eyestrain. The lighting in the work area should be adjusted to adequately meet the requirements—neither too little nor too much (Soeprapto et al. 2021). Work fatigue and decreased concentration may occur as a result of inadequate lighting required for seeing objects, while excessive lighting can result in glare. The recommended lighting intensity for tasks involving the visual identification of small objects, such as iron and steel, is set at 100 lux (Syekura & Febriyanto 2021).

This study conducted lighting measurements at ten specific locations on four fast missile boats. The lighting within the ships failed to adhere to the established standards because the lamps were used alternately, resulting in certain areas not having adequate lighting. Additionally, the vessel lacked ventilation, thus limiting natural lighting in some work areas (Ministry of Manpower of Republic Indonesia 2018). There was only a single streetlamp on the ship, and it moved around. The lamp's brightness was insufficient to adequately illuminate the entire space. Within the ships, there were three distinct tasks undergoing at different work areas. As a result, the workers who were positioned with their backs toward the light source experienced inadequate lighting. Due to the inadequate lighting conditions in the work areas, the workers' visual perception was compromised, necessitating increased eyestrain to clearly see objects. Symptoms that arise due to excessive eyestrain include headaches, decreased cognitive skills, and decreased concentration. These symptoms are indications of work-related fatigue (Suma'mur 2014).

The findings of this study revealed a statistically significant relationship between lighting and work fatigue among shipyard workers. As a result, the findings emphasize the importance of ensuring adequate illumination to mitigate the workers' fatigue. Previous studies showed similar results regarding the two variables (Yogisutanti et al. 2020, Adventina & Widanarko 2021). A negative correlation was observed between lighting and work fatigue. This indicates that a lesser intensity of lighting leads to a higher level of work fatigue.

### **Strength and limitations**

One notable aspect of this study is its novel approach to the measurements of noise and lighting that had not been previously documented at the research site. Moreover, this study may also motivate companies to conduct routine measurements to prevent the development of occupational diseases. However, the limitation of this study was that the data were collected during a period of low work intensity, thereby limiting the measurement of work fatigue.

### **CONCLUSION**

A relationship was found between shipyard workers' work fatigue and other factors, including nutritional status, physical workload, noise, and lighting. In contrast, shipyard workers' work fatigue did not exhibit a relationship with either age or working period. Companies should provide counseling services concerning the importance of healthy nutritional intake. Additionally, it is recommended that companies adjust workloads in accordance with their workers' capacity, conduct regular measurements of noise and lighting levels on board at least once annually, and monitor the equipment required for work on board, such as streetlamps and engine silencers. Lastly, companies need to enforce strict adherence to the use of personal protective equipment as a means of mitigating the risk of work fatigue.

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### **Conflict of interest**

None.

### **Ethical consideration**

This study was approved by the Health Research Ethics Committee of the Faculty of Dental Medicine, Universitas Airlangga, Surabaya, Indonesia (No. 032/HRECC.FODM/I/2022 on 26/1/2022).

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### **Author contribution**

SR contributed to the drafting and critical revision

of the article for important intellectual content. NW contributed to the final approval of the article and the provision of study materials. ED contributed to the analysis and interpretation of the data and the final approval of the article. SME contributed to the critical revision of the article for important intellectual content and statistical expertise. AAE contributed to the drafting of the article and the provision of administrative, technical, and logistic support. ANA contributed to the conception and design, as well as the collection and assembly of data.

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