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Noise Analysis, Lighting, Work Climate, Mechanical Vibration, Work Tenure and Nutritional Status Towards Fatigue

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Abstract

Work fatigue is an important problem that needs to be dealt with properly because it can cause a loss of efficiency at work, decreased productivity and work capacity as well as health and survival skills that cause workplace accidents. This study was aimed to analyze the factors that influence fatigue. Observational analytic research design with cross sectional approach was used with simple random sampling. The data collection techniques used observation and interviews. The sample of research was in the weaving department were 60 workers. The variables studied were noise, lighting, work climate, vibration, work tenure and nutritional status. Based on *Fisher's Exact Test* analysis, there is no relationship between noise and fatigue p= 0.611> α = 0.05. There is no relationship between lighting with fatigue p= 0.392 <α = 0.05. There is no relationship between work climate with fatigue p= 0.608> α= 0.05. There is no relationship between mechanical vibration with fatigue p = 0.199> α= 0. There is no relationship between work tenure with fatigue p= 0.309> α= 0.05. There is no relationship between nutritional status with fatigue p = 0.475> α = 0.05. The conclusion of this study is that there is no significant relationship between noise (p= 0.611), lighting (p= 0.392), climate (p= 0.608), vibration (p = 0.199), work tenure (p= 0.309), and nutritional status (p= 0.475) with work fatigue. For the further study, it is recommended to add other variables such as work shifts, sleep duration, financial conditions and a larger sample size.

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INTRODUCTION

Work fatigue is an important problem that needs to be addressed properly because it can cause various problems such as loss of efficiency at work, decreased productivity and work capacity as well as health and survival skills that cause workplace accidents. Fatigue is also a major cause of workplace accidents and will affect productivity (Verawati, 2016). According to the International Labor Organization (ILO), every year, there are two million workers die due to work accidents caused by fatigue (ILO, 2013).

Fatigue is the physical and mental condition of a person who is exhausted so they cannot carry out their functions normally (Anggraini *et al*. 2013). Decreased productivity and work concentration are the effects of fatigue (Narulita *et al*. 2018). Factors causing fatigue are medication, naps, illegal drugs, alcohol, education, social level, income, marital status, care, dependency, eating habit and type of food, ambient heat / cold, noise, lighting, chemicals, sleeping length, physical workload for work motivation, work arrangements, shifting time and rest time, work recovery time, type of commuter, position at work, monotonous, and work stress. Circadian time structure, endurance, age, sex, race, nutritional status, BMI, and personality (Di Milia *et al*. 2011).

Lack of sleep can also cause changes in cytokine tissue. So, the immune system will work less effectively (Nopitasari, Rahayu, 2018). Work fatigue is a subjective symptom of fatigue that workers complain about which are all unpleasant feelings, Measurement of fatigue uses *reaction timer Lakassadiya* (Maurits, 2010).

Mahnaz Saremi *et al*. (2015) showed that noise exposure has a significant effect on fatigue. From the results of Laziardy's research (2017) shows the level of noise influences the fatigue of workers where the higher the intensity of noise, the higher the level of fatigue of the worker.

Research of Yuan *et al*. (2011) states that there is a significant correlation between the level of fatigue and light exposure (r = -0.28 to -0.45) and in Setiawan's research (2016) shows that there is a relationship between welding light intensity with fatigue eye on PT. X in Gresik Regency (Setiawan, 2016). Whereas Lin, Feng, Chao, & Tseng (2008) research results show that visual acuity and subjective visual fatigue are significantly affected by the color of light.

Workers who are exposed to hot environments tend to experience subjective fatigue, and their symptoms of fatigue increase with the level of heat exposure (Chen *et al*. 2010). Widowati's research shows that an increase in vibration intensity of 1 m / s2 will be followed by an increase in respondents' eye fatigue (Widowati, 2011). There is a relationship between work tenure with fatigue experienced by workers in the sewing department at *CV. Various Garment*, according to the researchers, shows the influence of the length of the work tenure of workers (Atiqoh *et al*. 2014a).

Whereas, Paulina & Salbiah study (2016) states that there is a significant relationship between work tenure and worker fatigue. The work tenure is an accumulation of one's work activities carried out over a long period of time; if the activity is carried out continuously, it will cause interference with the body. Physical pressure at any given time results in reduced muscle performance, with symptoms of lower movement (Koesyanto Herry, 2013).

The less energy intake and the higher the BMI, the higher the level of work fatigue in workers (Sari & Muniroh, 2017). The effects of obesity cause frequent fatigue (Pajoutan & Cavuoto, 2016). In Adi's research (2013), there was a significant relationship between nutrition intake before work and the level of fatigue. The purpose of this study was to analyze the factors that influence the occurrence of work fatigue in employees at PT. Iskandartex, where researchers prefer to examine the noise, lighting, work climate, vibration, work tenure and nutritional status

METHOD

The research design was observational analytic research with cross sectional approach. The population of this study was 150 workers in the *weaving* section with a sample of 60 respondents.

The sampling technique used was simple random sampling technique. Data collection techniques used observation, measurement in the field and interviews with workers.

RESULT AND DISCUSSION

Table 1. Distribution of Noise frequency, lighting, work climate, mechanical vibration, work tenure, nutritional status and work fatigue.

No	Variable	Criteria	Frequency		Percentage (%)	
1.	Noise	>T.L.V < T.L.V	41	19	68.3	31.7
		Total	60		100,0	
2.	Lighting	> T.L.V < T.L.V	44	16	73.3	26.7
		Total	60		100,0	
3.	Work climate	> T.L.V < T.L.V	44	16	73.3	26.7
		Total	60		100.0	
4.	Mechanical Vibration	> T.L.V < T.L.V	46	14	76,7	23.3
		Total	60		100,0	
5.	Work tenure	> 5 years < 5 years	43	17	71.7	28.3
		Total	60		100,0	
6.	Nutritional status	Normal Thin	55	5	91.7	8.3
		Total	60		100,0	
7.	Work fatigue	Mild Moderate	53	7	88.3	11.7
		Total	60		100.0	

The frequency of independent variables and the dependent variable shows that 68.3% workers exposed to noise that exceeds the *Threshold Limit Value (T.L.V)* and workers exposed to noise below the T.L.V are 19 (31.7%). The lighting variable shows that out of 60 samples the workers who received the lighting intensity exceeded the T.L.V of 44 workers (73.3%). Work fatigue can be caused by work climate that is not in accordance with T.L.V. Based on table 1. it can be interpreted that from a total of 60 workers samples, the work climate that exceeds T.L.V is 44 workers (73.3%). The mechanical vibration variable shows the value of mechanical vibration intensity that exceeds the T.L.V of 46 (76.7%). Working tenure is one of the factors causing work fatigue, from the results of table 1 it can be interpreted that from a total of 60 sample workers, the conditions of workers working more than 5 years were 43 samples (71.7%). Normal nutritional status showed that 55 (91.7%) workers were in the normal category while workers in the thin category were 5 workers (8.3%). Results of Table 1 showed 53 (88.3%) workers experienced mild fatigue and 7 workers experienced moderate fatigue (11.7%).

Relationship of noise and work fatigue

Table 2. Relationship of noise and work fatigue

Noise	Work fatigue						*p Value*
	Mild	%	Moderate	%	N	%	
> T.L.V	36	87.8	5	12.2	41	68.3	0.611
< T.L.V	17	89.5	2	10.5	19	31.7	
Total	53	88,3	7	12.7	60	100	

It can be interpreted that from a total of 60 samples, the noise category groups above the T.L.V associated with mild fatigue were 36 (87.8%) samples, while those experiencing moderate fatigue were 5 (12.2%) samples. Fisher's Exact Test analysis results obtained p = 0.611 is greater than α=0.05 meaning that there is no statistically significant relationship between noise and fatigue.

Relationship of lighting and work fatigue

Table 3. Crosstab test results between lighting and work fatigue

Lighting	Work fatigue						*p Value*
	Mild	%	Moderate	%	N	%	
> T.L.V	38	86.4	6	13.6	44	73.3	0.392
< T.L.V	15	93.8	1	0	16	26.7	
Total	53	83.3	7	13.6	60	100	

It can be interpreted that out of a total of 60 samples, the information category groups associated with fatigue that exceeded T.L.V were 38 (86.4%) and those under T.L.V were 15 samples (93.8%). *Fisher's Exact* Test analysis results obtained p value = 0.392 is greater than the value α = 0.05 meaning that there is no statistical relationship between lighting with fatigue.

The relationship of work climate and fatigue

Table 4. Results of *crosstab* test of work climate and fatigue

Work climate	Work fatigue						*p Value*
	Mild	%	Moderate	%	N	%	
> T.L.V	39	88.6	5	11.4	44	73.3	0.608
< T.L.V	14	87.5	2	12.5	16	26.7	
Total	53	83.3	7	23.9	60	100	

It can be interpreted that from a total of 60 samples, the working climate category above the T.L.V category experienced 44 (73.3%) fatigue, while the work climate category under the T.L.V was 16 (26.7%). Fisher's Exact Test results obtained p value = 0.608 is greater than the value of α = 0.05 meaning that there is no statistical relationship between work climate with fatigue.

The relationship of mechanical vibration and fatigue

Table 5. *Crosstab* test results between Mechanical Vibration and Fatigue

Mechanical Vibration	Work fatigue						*p Value*
	Mild	%	Moderate	%	N	%	
> T.L.V	42	91.3	4	8.7	46	76.7	0.199
< T.L.V	11	78.6	3	21.4	14	23.3	
Total	53	93,3	7	11.67	60	100	

It can be interpreted that out of a total of 60 samples, the group of mechanical vibration categories was above the T.L.V were 46 (76.7%) samples and a total of 14 (23.3%) in mechanical vibrations below the T.L.V. Fisher's Exact Test analysis results obtained p value = 0.199 is greater than the value of α = 0.05 meaning that there is no statistical relationship between mechanical vibration with fatigue.

Relationship of work tenure and work fatigue

Table 6. Crosstab test results between work tenure and work fatigue

Work tenure	Work fatigue						*p Value*
	Mild	%	Moderate	%	N	%	
> 5 years	39	90.7	4	9.3	43	71.7	0.309
< 5 years	14	82.4	3	17.6	17	33.3	
Total	43	3.1	7	11.6	60	100	

It can be interpreted that from a total of 60 samples, the work tenure category who has above 5 years experienced work fatigue as many as 43 (71.7%) samples, while samples with work tenure under 5 years experiencing work fatigue were 17 samples (33.3%). *Fisher's Exact* analysis results obtained *p* value = 0.309 is greater than the value of α = 0.05, it means that statistically there is no relationship between work tenure with fatigue.

Relationship of nutritional status and fatigue

Table 7. *Crosstab* test results between nutritional status and fatigue

Nutritional status	Work fatigue						*p Value*
	Mild	%	Moderate	%	N	%	
Thin	4	6.7	1	1.7	5	8.3	0.475
Normal	49	81.7	6	6	55	91.7	
Total	53	88.4	7	7.7	60	100	

It can be interpreted that from a total of 60 samples, the thin nutritional status group experienced fatigue as many as 5 (8.3%) samples and the normal nutritional status category group experienced fatigue as many as 55 (91.7%) samples. it means that statistically there is no relationship between nutritional status with fatigue, but according to the clinic there is a relationship between nutritional status with work fatigue due to the difference in proportion> 20% and it can be concluded that the relationship between nutritional status and fatigue has a sufficient correlation value with a value of p=0.475 (Dahlan, Sopiyudin., 2010).

Based on observations field, the average measured value of noise intensity exceeds the T.L.V of 96.76 dB, the results of the Fisher's Exact Test analysis show that the value of p = 0.611 is greater than α = 0.05, meaning that there is no statistical relationship between noise and fatigue, but clinically, there is a relationship between noise and fatigue due to the difference in proportion> 20% and it can be concluded that the relationship between noise and fatigue has a strong correlation value with p value = 0.611, many workers do not wear personal protective equipment but there are some who already use ear plugs they make themselves from cotton rolls. Researchers assess that noise is not a major factor in work fatigue, because workers are accustomed to noisy conditions in the work environment, in addition, workers have also adapted to loud

noises so they are accustomed to receiving noise. This is in line with research from Hoffmann et al. (2018) which states in the study of workers using headsets equipped with electronic limiter so that the fatigue measurement obtained noise exposure received by workers does not cause fatigue.

Visual fatigue becomes more serious with increasing work tenure (Wang et al., 2016). Fisher's Exact Test analysis results obtained p value = 0.392 is greater than α = 0.05 means that statistically there is no relationship between lighting with fatigue, but clinically there is a relationship between lighting with fatigue due to the difference in proportion >20% and the conclusion can be concluded between lighting and fatigue has a sufficient correlation value with p = 0.392. This study is in line with Sitorus & Purbo's 2011 research which states that there is no significant relationship between lighting intensity and eye fatigue (p value = 0.122) (Sofiati, Sitorus, & Purba, 2011). This is in line with the study of Odi et al. (2018) which states there is no relationship between lighting with work fatigue in tailors, while in the study Sofiati et al., (2011) also states there is no significant relationship between lighting intensity and eye fatigue.

Fisher's Exact Test analysis results obtained p value = 0.608 is greater than the value of α = 0.05 it is statistically there is no relationship between work climate with fatigue, this is in line with research of Andriani (2016) which states there is no relationship between air temperature of PT. X Jakarta and subjective fatigue. Workers in the weaving section are indirectly related to the hot work climate during the daytime, because the building in the weaving section is roofed with asbestos and there are weaving tools that cause heat. Workers in the weaving section on averagely have worked within the same period of ± 5 years, this causes workers to become accustomed to the climate because it has been acclimatized to the climate well. This is in line with research from Stariszky, Ekawati, & Jayanti (2016) which states there is no relationship between work climate and work fatigue (Stariszky, Ekawati, & Jayanti, 2016).

Chronic exposure to whole body vibrations can affect the digestive system, lumbar spine, peripheral blood vessels, and vestibulocochlear system (Yilmaz & Ila, 2019). Fisher's Exact Test analysis results obtained p value = 0.199 is greater than the value of α = 0.05, it means there is no relationship between mechanical vibration and fatigue, but clinically there is a relationship between vibration and fatigue due to the difference in proportion > 20%, it can be concluded that the relationship between mechanical vibration and fatigue has a weak correlation value with a value of p= 0.199. This is in line with research of Rusdjijati et al. (2010) which stated that there was no significant effect between exposure to the vibration of the driver's seat and length of work on the bus driver's work fatigue (Rusdjijati, Setyawati, & Prakoso, 2010). Other factors related to social-psychological problems, both related to work and work environment, such as rest periods, inadequate salary standards, arrangements for leave schedules that are often unclear, and career problems. Generally the decrease in the reaction time of night shift workers is greater than the reaction time of day shift workers (Maurits, 2010).

Fisher's Exact analysis results obtained p value = 0.309 smaller than the value of α = 0.05 which means there is no relationship between work tenure and fatigue, but clinically there is a relationship between tenure and fatigue due to the difference in proportion> 20%. This is in line with Ekawati's research, Suroto 2017, that there is no relationship between work tenure and the level of work fatigue in workers who make spring rolls in Kranggan Subdistrict, Central Semarang District (Kusgiyanto, Suroto, & Ekawati, 2017).

The results showed that the level of work fatigue is even more experienced by workers with long working tenure. In this case, years of work can affect workers both positively and negatively. Positive influence occurs when the longer a worker works, the experience will be in doing his work. Conversely, a negative effect occurs when the longer a worker works will cause fatigue and boredom, especially with monotonous and repetitive work activities. This is because the weaving part of the work is not a type of work that requires special abilities in its implementation so that both workers with new tenure and workers

with long tenure, both are equally capable of carrying out work properly so that the level of fatigue they experience is relatively the same if measured by same workload and work time.

The results of this study using Fisher's Exact analysis obtained p value = 0.475 is greater than the value of α = 0.05, meaning that there is no statistical relationship between nutritional status with fatigue, this is in line with research by Ellen et al. (2016) in a study with female subjects stated that there was no relationship between nutritional status and fatigue index (Ellen A. Schur, Noonan, Smith, & Buchwald, 2007). This is also the same as the study of Chesnal et al. (2013) which states there is no relationship between age, sex, nutritional status with work fatigue in workers in the production section of PT. Putra Karangetang Popontolen Selatan Minahasa (Chesnal et al. 2013).

From observations at the time of the study, in addition to food intake itself, work fatigue is also very likely due to variables that was not examined in this study, such as work position and circadian rhythm, the position of workers at work which requires them to stand up a lot, so work occurs static muscles that contract continuously will cause fatigue that static contractions continuously do not get glucose and oxygen from the blood and must use food reserves available in the muscles.

CONCLUSION

The conclusion of this study is that there is no significant relationship between noise (p=0.611), lighting (p=0.392), climate (p=0.608), mechanical vibration (p= 0.199), work tenure (p=0.309), and nutritional status (p=0.475) with work fatigue. for the further research, it will be recommended to add other variables such as work shifts, sleep duration, socioeconomic conditions and a larger sample size.

It is necessary to use damping material that is in accordance with the standard to protect the workforce from noise intensity that exceeds the T.L.V. The company needs to hold engineering manipulation to reduce engine vibrations in the weaving section. The provision of supplements and mineral water is also needed for the intake of minerals and fluids for workers who work in environments with temperatures exceeding 300C, in addition to ventilation and air flow must be adjusted to the work environment standards according to Indonesia National Standard, and set a total rest time for workers at least 1 hour after working for four hours.

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