

Analysis of Work Fatigue in Preventing Work Accidents: A Case Study of Human Comfort Pulse Rate in Wood Processing Industry Workers

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ABSTRACT

Work fatigue in workers in companies can trigger work accidents, which can hurt the company's work and productivity. Work fatigue can easily result in loss of concentration, so fatigue is often the cause of accidents and deaths. Work comfort for workers needs to be prioritized as a culture of health, safety, security, environment, and quality. This study uses a quantitative approach that aims to analyze fatigue through worker human comfort with a pulse rate indicator as a parameter in monitoring the risk of work accidents in wood processing industry workers. The population in this study was 30 heavy equipment operators in the plywood industry with a total sampling technique. Data analysis using SPSS IBM 20. The results of the study showed an average increase in cardiovascular load of 62.73% and peak work fatigue occurred at 11:30 and 15:30 AM. Companies need to pay attention to safety at these risk hours by evaluating the arrangement of rest and production hours.

Keywords: work fatigue; human comfort; pulse rate; workers; wood industry.

INTRODUCTION

Every work or series of activities carried out in an integrated and sustainable manner to maintain and improve the health of the population through disease prevention, health improvement, disease treatment, and health recovery by the government or the population is a health effort. Humanity, balance, usefulness, protection, respect for rights and obligations, justice, gender, and non-discrimination are the foundations of implementing health development. As an investment in the development of socially and economically productive human resources, the goal of health development is to increase the awareness, desire, and ability of each person to live healthily. This will ensure the highest possible level of public health. (Hafiz & Marinescu, 2023).

Work and life must be balanced, problems will arise when nurses fail to balance work time with time for personal life or family. Work and personal life are two important domains in life. Both roles often cause

conflict between work and personal life, such as long working hours that can reduce presence at home, missing personal activities, and togetherness with family (Caproni, 2004).

It is acknowledged that the incidence of work-related accidents is still very high in the world, with more than 4,275 cases resulting in disability and death in 2020, which can threaten lives and company productivity. (Aishakina, Dewi, & Rahayu, 2021). Based on the Social Security Administering Agency (BPJS) Employment, there were 234,270 cases of work accidents. Work accidents in Indonesia when in 2021. The number reached 221,740, up 5.65 percent from the previous year. This pattern shows that the total work accidents in Indonesia have always increased over the past five years. There have been 123,040 accidents. In the workplace since 2017. In 2018, there were 173,415 cases, up 40.94%. The number of work accidents rose 5.43 percent to 182,835 a year later. There were 221,740 work accidents in the country in 2020, up 21.28 percent.

The number also increased once again in the previous year (Dewi, Yuniarti, & Santoso, 2023).

Burnout is a condition of emotional, mental, and physical exhaustion caused by prolonged or repeated stress. Although most often caused by problems in the workplace. Many aspects The source of fatigue in workers is related to work-related accidents such as exposure to excessive activity and the risk of causing trauma, thus disrupting work-life balance in individuals. (Ajayi & Udeh, 2024). Workers are part of a company's very important assets. This is because, with workers who are persistent, skilled, and healthy, the effectiveness of raw material processing will be optimal, which will have an impact on the profits that will be obtained by the company. Therefore, occupational health and safety are not just the obligations of the individual concerned, but the business institution that employs the person must also take part in protecting occupational health and safety so that the performance of the worker can be optimal. (Melamed, Rabinowitz, Feiner, Weisberg, & Ribak, 1996).

Occupational Health and Safety and Environment (K3L) is our effort to create a safe and healthy work environment to reduce the possibility of accidents and illnesses in the workplace caused by carelessness, which can demotivate employees and reduce productivity. (Kaban, Suroyo, & Utami, 2024). Safety Culture focuses more on safety (promoting safety) and emphasizes the contribution of interpersonal relationships, work units, and the organization as a whole in forming basic assumptions about individuals in an organization that is always developing toward safety. Work comfort for workers needs to be a priority as a culture of health, safety, security, environment, and quality. (Bautista-Bernal, Quintana-García, & Marchante-Lara, 2024).

One way to determine the level of fitness of workers is by measuring the pulse rate. The pulse rate for normal people is the same as the heart rate between 60-80 times/minute. Pulse rate is one of the human health indicators that requires regular monitoring because it describes a person's physical health response. Monitoring aims to determine the normality of the pulse to prevent physical disorders that have fatal consequences for industrial workers.

REVIEW OF LITERATURE

Work fatigue is a condition in which a person feels very tired. Fatigue can be caused by working too long hours, doing too much physical and mental activity, not enough rest, excessive stress, and a combination of these factors (Government of Alberta, 2010). Work fatigue is a feeling of tiredness, a decrease in alertness, and the total response of an individual to psychosocial stress experienced in a certain period and work fatigue tends to reduce employee performance, motivation, and work productivity. Work fatigue cannot be defined but can be felt so that the determination of work fatigue can be known subjectively based on the feelings experienced by workers. Work fatigue can cause work accidents (Hockey, 2013).

Human Comfort

Human comfort is a condition of a person's feelings that feel comfortable based on each individual's perception. Comfort is a condition where basic human needs that are individual in nature have been met due to several environmental condition factors. (Parsons, 2019). Physical indicators that indicate that humans feel comfortable can be observed through vital signs such as pulse, blood pressure, and body temperature.

The pulse is a wave that can be felt and felt in the arterial area from the pumping of the heart to the blood vessels. 5 The pulse can be felt or felt in arteries that are close to the surface of the body, such as the temporal artery, dorsal pedal artery, brachial artery, radial artery, and carotid artery located at the height of the thyroid cartilage. 6 In normal people, the pulse frequency is the same as the heart rate. The heart rate frequency can easily be measured by measuring the pulse rate. (Christensen & Kockrow, 2013).

Occupational Safety

Occupational Health and Safety and the Environment is an effort to create a safe and healthy work environment by reducing the possibility of accidents and illnesses in the workplace caused by carelessness that can demotivate employees and reduce productivity. (Sholihah, 2018). Occupational Health is an effort to ensure workers can live healthily, free from health problems and negative effects caused by work.

Safety procedures must always be followed to minimize the occurrence of work accidents, such as disability and death due to work. (Mollona, De Neve, & Parry, 2020). 5 factors have the most influence on occupational safety and health in the workplace, namely material and layout factors, environment, operations, humans and machines, and skills. (Yusida, Suwandi, Yusuf, & Sholihah, 2016)

METHODOLOGY

This research is a quantitative research with an observational approach. (Sholihah, 2020) which aims to analyze the fatigue aspect through the human comfort of workers. Measurement of *work heart rate* used as a parameter in monitoring the risk of work accidents in wood processing industry workers. The research variable is the fatigue condition of heavy equipment operators after and before carrying out work activities with the parameter of measuring the worker's pulse rate.

Population and sample

This study is for all operators who operate heavy equipment in a plywood company with a total of 30 people using the total sampling method where all operators are used as research samples. Variables This study is about the fatigue conditions of heavy equipment operators before and after carrying out work activities.

Data collection techniques

Data collection techniques are carried out by directly measuring the pulse of workers. Observation of measurements pulse rate is measured when the operator is carrying out activities at work and rest. The working pulse rate is measured in real time for 6 consecutive working days starting at 08.00 – 12.00 AM and 13.00 – 16.00 AM. The resting pulse rate is measured in real-time before work at 07.30 – 08.00 AM during the lunch break at 12.30 – 13.00 AM, and after finishing work at 16.30 – 17.00 AM.

Heart Rate Rease (HRR) measurement is based on work heart rate, rest heart rate, and maximum heart rate data. To determine the increase in work heart rate (heart rate reuse) is measured based on the operator's cardiovascular load with the following formula:

$$HRR = \frac{WHR - RHR}{MHR - RHR} \times 100\%$$

Data Analysis

Data analysis using the IBM SPSS 20 application (Kulas, Roji, & Smith, 2021)with the T-test which aims to analyze the differences in the average heart rate of workers when the operator is working (work heart rate) and analyzing work fatigue is an increase in the work heart rate (heart rate release).

Where: HRR = Heart Rate Rease, WHR = Work Heart Rate, MHR = Maximum Heart Rate. The level of operator work fatigue is based on the increase in work heart rate (Cardio Vascular Load) as in Table 1.

TABLE 1: Job Fatigue Categories Based on CVL.

No	Heart Rate Rease	Fatigue Level
1	≤ 30 %	Not Tired
2	30% - 60%	Mild Fatigue
3	60% - 80%	Moderate Fatigue
4	80% - 100%	Very Fatigue
5	>100%	Extreme Fatigue

Measurement of workload based on work pulse rate is the average value of the pulse rate measurement results when the operator carries out work activities, with the provisions as shown in Table 2.

TABLE 2: Workload Categories Based on Work Heart Rate.

No	Work Pulse (beats/minute)	Workload
1	≤ 100	Mild
2	>100 - 125	Moderate
3	>125 - 150	Heavy
4	>150 - 175	Very Heavy
5	>175	Extreme Heavy

RESULTS

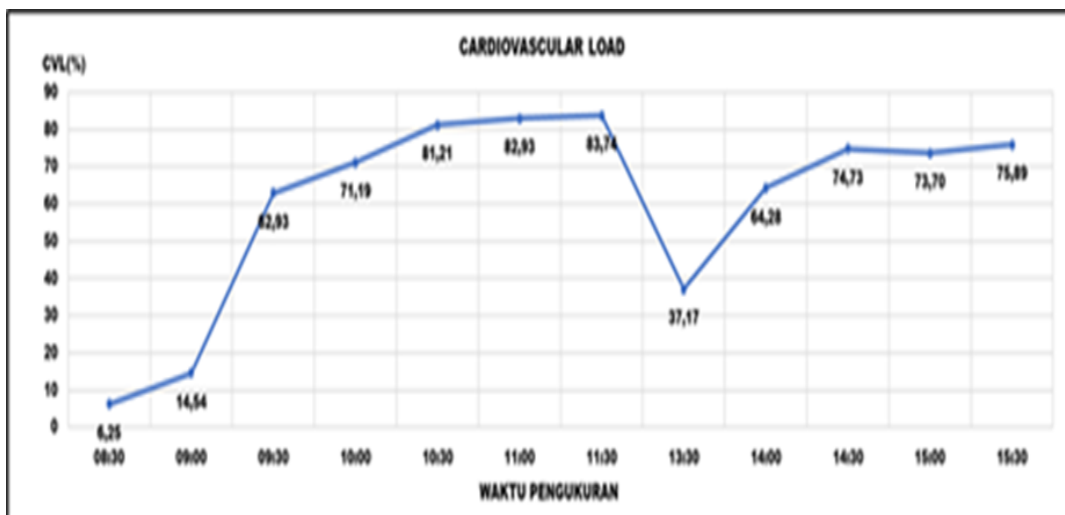


FIGURE 1: Results of Analysis of Increased Work Pulse Rate.

Source: Research data (2024).

Based on the results of Figure 1 above, shows that the average increase in Vascular Load(CVL) is 62.73%. The pulse rate before the lunch break increased significantly from 09.30 – 10.00 AM and

peaked at 11.30 AM. The pulse rate after the lunch break also increased significantly from 14.00 – 15.30 and peaked at 15.30. So the peak of work fatigue occurs at 11.30 and 15.30 AM.

TABLE 4: Results of the Average Difference Test of Work Pulse Rate Data.

One-Sample Test							
	Test Value = 88.05						
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference		
					Lower	Upper	
Denyut 08:30 ok	.018	35	.986	.006	-.62	.63	
Denyut 09:00 ok	1.585	35	.122	.533	-.15	1.22	
Denyut 09:30 ok	.767	35	.448	.228	-.38	.83	
Denyut 10:00 ok	2.522	35	.016	.811	.16	1.46	
Denyut 10:30 ok	2.543	35	.016	1.117	.23	2.01	
Denyut 11:00 ok	4.829	35	.000	1.894	1.10	2.69	
Denyut 11:30 ok	4.620	35	.000	1.728	.97	2.49	
Denyut 13:30 ok	-.587	35	.561	-.189	-.84	.46	
Denyut 14:00 ok	1.720	35	.094	.700	-.13	1.53	
Denyut 14:30 ok	3.249	35	.003	1.450	.54	2.36	
Denyut 15:00 ok	3.680	35	.001	1.394	.63	2.16	
Denyut 15:30 ok	4.709	35	.000	1.644	.94	2.35	

Source: data processed by researchers (2024).

Based on table 4 above, shows the results of the one-sample t-test with $\alpha = 5\%$, there is a significant difference between the average resting heart rate data and the average working heart rate.

DISCUSSION

Human Comfort Description of Heart Rate in Wood Processing Industry Workers

The results of the study showed that the human comfort of workers with the pulse rate indicator mostly increased. This means that the work fatigue that occurs as a result of work activities. Changes in heart rate Heart_Rate_Change ($\beta = 0.827$) indicate that an increase in heart rate from rest to maximum work has a significant impact on work fatigue, each increase in heart rate is always followed by an increase in work fatigue.

The results of this study also support that fatigue can result in an increased risk of cardiovascular disease in workers. Controlling risk factorsThe need for rest and changing work shifts contribute to obesity, diabetes, hypertension, and an increased risk of cardiovascular disease. (Gohari, Wiebe, & Ayas, 2023). Stress and fatigue at work are related and pose a greater risk of death in workers with a history of cardiovascular disease (Matthews, Chen, & Li, 2023).

Peak work fatigue in workers with increased heart rate occurs at 11.30 and 15.30 AM. If this condition occurs for a long time and is not immediately anticipated, a Rapid heart rate can cause serious complications, such as stroke, heart failure, cardiac arrest, and even death. In addition to age factors, unhealthy lifestyles, hereditary factors, and congenital diseases can worsen the condition of workers. Research also suggests that occupational exposure to high levels of noise and night shift work may be associated with the risk of coronary heart disease. (Eng et al., 2023).

Fatigue Analysis in Wood Processing Industry Workers

The results of the study showed that there was work fatigue due to work activities. Changes in heart rate Heart_Rate_Change ($\beta = 0.827$) showed that there was an increase in heart rate from the resting phase to maximum work which had a significant impact on work fatigue, where every increase in heart rate was always followed by an increase in work fatigue.

The results of this study support previous research which stated that there is a correlation between complaints of fatigue in apparently healthy individuals characterized by an increased heart rate (Nelesen, Dar, Thomas, & Dimsdale, 2008). Something similar is also stated in building construction workers who experience fatigue which is characterized by an increase in vital signs such as pulse rate and temperature have been identified as being more likely to suffer from the risk of accidents in work safety. (Namian, Taherpour, Ghiasvand, & Turkan, 2021). The main factors that influence safety performance are organizational management capabilities, resources, location management, and workforce scheduling. (Durdjev, Mohamed, Lay, & Ismail, 2017). Fatigue at work can result in an imbalance in life, thus disrupting the role and function of the family. (Kuncoro, Zuhriyah, Putra, & Lenggono, 2024). The results of the study also showed that the level of fatigue of wood processing heavy equipment operators was 0-30% indicating no fatigue, 31-60% indicating mild fatigue, 61-80% indicating moderate fatigue, 81-100% indicating severe fatigue, and if the number is more than 100% indicating extreme fatigue.

The impact of abnormally high heart rate (<70 or ≥ 80 bpm) can be associated with increased risk and threat of cardiovascular death among coronary heart disease patients. Continuous heart rate monitoring can help to reduce health risks and offer early intervention to patients concerned. (Ma, Gao, Mao, & Wang, 2022).

The role of company management in evaluating work safety is very much needed in the health and safety management system through company commitment and quality assurance. (Wibowo & Sajiyo, 2023). PQuality assurance is a guarantee of physical and spiritual well-being, integrity, and perfection of humans, as well as their work and culture, for the benefit of society as a whole and humans in particular. defines work safety as a state of avoiding danger while working. The application of discipline is very much needed in carrying out efforts to form positive behavior because work discipline can be a mediating factor in the formation of compliance (Lenggono et al., 2023).

When workers are directly involved in occupational safety and management commitment to safety is demonstrated, a safety culture will be more effective. Workers can participate in occupational safety in a variety of ways, including actively participating in occupational health and safety activities, providing input on environmental hazards, carrying out activities safely, contributing to the development of safe work procedures and methods, and reminding others about employee health and safety hazards as components of a safety culture. (Hudson, 2001).

CONCLUSIONS

The results of the study showed an average increase in work heart rate (cardiovascular load) of 62.73%. The peak increase in heart rate before lunch break occurred at 11:30. The heart rate after lunch break peaked at 15:30. So the peak of work fatigue occurred at 11:30 and 15:30. Companies need to pay attention to safety at these risk hours by evaluating the arrangement of rest and production hours.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest concerning the research, authorship, and/or publication of this article.

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