

ANALYSIS OF THE EFFECT OF CARBONMONOXIDE EXPOSURE AND CHARACTERISTICS OF WORKERS ON WORK-RELATED FATIGUE IN WORKERS OF FISH SMOKING CENTER

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ABSTRACT

Title: Analysis of the Effect of Carbonmonoxide Exposure and Characteristics of Workers on Work-related Fatigue in Workers of Fish Smoking Center

Background: Work-related fatigue is one of occupational health and safety problems that can be a risk factor for work-related accidents. ILO has recorded that every year, two million workers died because of work-related fatigue. There are many factors contributing to work-related fatigue, among others, age, sex, work load, work environment, and Carbon Monoxide exposure. The aim of the research was to observe the effect of Carbon Monoxide exposure and the characteristics of workers to work-related fatigue in workers in Fish Smoking Center, Wonosari Village, Demak Regency.

Method: The research used cross sectional design using 42 samples. The data were analyzed using Multinomial Logistic Regression conducted on SPSS.

Result: The research shows that 61.9% respondents experience work-related fatigue. Bivariate analysis suggests that age and sex aren't significantly related to work-related fatigue, while employment period, work load and Carbon Monoxide exposure are significantly related to work-related fatigue. The result of multivariate analysis shows that work load (p=0,009) and Carbon Monoxide exposure (p=0,034) are significantly related to work-related fatigue. Work load is the dominant variable for work-related fatigue. Workers having heavy work load are exposed to work-related fatigue 12 times higher compared to those with light work load.

Conclusion: The management of fish smoking center is expected to provide appropriate break and require the workers to wear mask during working hours.

KEYWORDS: work-related fatigue, age, sex, employment period, work load, carboxyhemoglobin

INTRODUCTION

Work-related fatigue is one of problems of occupational health and safety that is subjective and can be a risk factor for a work-related accident.¹ Work-related fatigue might decrease work motivation and performance, increase errors, decrease work productivity, and lead to work-related accident.² WHO has predicted that fatigue is the second leading cause of death after heart disease.³ ILO mentioned two million workers died because of work-related accidents caused by fatigue.⁴

A research in Japan suggests that 65% of workers experienced work-related fatigue.⁵ Around 58.5% of factory workers in a company in Makassar, Indonesia suffer from work-related fatigue.⁶ In

Semarang, around 43.3% of parking attendants suffer from light fatigue and 56.7% medium fatigue.⁷ From another research conducted to workers of workshops in Pontianak, around 43.9% of workers are categorized as tired, 41.5% are categorized as fatigue, and 14.6% are categorized as less-tired.⁸ A research conducted to workers making crackers in Semarang shows that 60.9% of subjects suffer from fatigue.⁹ It can be concluded that both formal and informal workers are experiencing work-related fatigue.

Fatigue are caused by several factors, such as individual factors, environmental factors, and psychological factors.⁸ Individual factors are, among others, age, anemia status, nutritional status, smoking habit, sex, and quality of sleep.^{3,10,11} An individual who grows older, has a declining ability to work because he/she feels tired and is unable to move quickly.^{12,13} Woman has a maximum measured Oxygen volume at 15-30%, lower than man, causing higher fat percentage and lower hemoglobin. It results in the fact that woman tends to get tired earlier compared to man.¹⁴ Employment period also correlates to work-related fatigue. The longer employment period leads to higher level of fatigue.⁶

Environmental factors that influence the level of fatigue are noise and exposure to carbon monoxide gas (CO).¹⁵ Research at Navi Mumbai states that most people who are on the main road suffer from health problems due to dangerous CO level. This problem was also found in traffic police who work more than 8 hours per day, roadside employees, and janitors with an average work period of six months.¹⁶

Carbon monoxide is a colorless, odorless, and tasteless gas. This gas is toxic to animals and humans in high concentrations. In the United States, there are 20,000 cases in emergency rooms related to CO gas every year. The concentration of carbon monoxide at 667 ppm might alter 50% of hemoglobin in the body to carboxyhemoglobin.¹⁷

Wonosari Village in Demak Regency, Central Java, is one of the national pilot markets in structuring and processing smoked fish. At least 225 fish smoking business owners started this business 10 years ago and made it as a community economic activity.¹⁸ Smoking is conducted to preserve fish. Smoke is obtained from the burning of corn cobs. Non-carbonated corn cobs produce CO emissions.^{19,20} The level of CO has been known as one of contributing factors to work-related fatigue.²¹

Contributing factors to work fatigue associated with working environment having high CO levels are the reasons why researchers want to see how the CO exposure and worker characteristics influence work fatigue in workers of Fish Smoking Center in Wonosari Village, Demak Regency in 2019.

METHODS

This research was a quantitative study with a cross sectional design. The research was conducted in May 2019 in Fish Smoking Center, Wonosari Village, Demak Regency. The population was 225

people with a sample of 42 people. Samples were taken based on nonrandom sampling method. The data for work-related fatigue was measured using reaction timer Lakkasidaya 7.7, work environment was measured using QUESTemp digital, work load was measured using fingertip oximeter, exposure of carbon monoxide was measured by taking blood sample using spectrophotometer, and characteristics of workers were obtained from questionnaire-based interview. The data obtained were described univariately. Bivariate analysis was conducted using the chi-square test and multivariate analysis was conducted using multiple linear regression tests to see the effect of both independent and dependent variables

RESULTS

Half of the workers are <35 years old. Most of the respondents are female workers. Around 57,1% of the respondents have worked less than 5 years. Most of the workers have medium work load, while the others have light work load. Workers’ exposure to carbon monoxide was categorized as above normal. Work-related fatigue was experienced by 61.9% of respondents and the others had light fatigue. (Table 1).

Table 1 The Result of Univariate Analysis

Individual Characteristics	Category	n	Percentage (%)
Age	< 35 years old	21	50
	≥ 35 years old	21	50
Sex	Male	14	33,3
	Female	28	66,7
Employment Period	< 5 years	24	57,1
	≥ 5 years	18	42,9
Work Load	Light	19	45,2
	Medium	23	54,8
Exposure to Carbon Monoxide	Normal	17	40,5
	Above normal	25	59,5
Work-related Fatigue	Light	16	38,1
	Medium	26	61,9

There are only three independent variables which have a significant correlation with work fatigue, namely the employment period ($p=0,031$), work load ($p=0,007$), and exposure to carbon monoxide ($p=0,009$). After conducting multivariate analysis, the results of the multiple logistic regression tests were variables that were significantly related to work fatigue, namely workload and carbon monoxide exposure, while sex and employment period were variables of control. Based on the value of OR, workers with higher work load are prone to work fatigue 12 times higher, after being controlled by the following variables: sex and employment period (Table 2 dan 3).

Table 2 The Result of Bivariate Analysis

Independent Variable	PR (CI=95%)	P- value	Remarks
Age	2,273 (0,634–8,146)	0,340	Not correlated
Sex	0,315 (0,072–1,378)	0,217	Not correlated
Employment Period	5,909 (1,349–1,086)	0,031	Correlated
Work Load	8,143 (1,958–33,867)	0,007	Correlated
Exposure to Carbon Monoxide	7,333 (1,815–29,630)	0,009	Correlated

Table 3 The Result of Multivariate Analysis

Independent Variable	B	p- value	OR	CI (95%)
Age	1,609	0,135	0,200	0,024-1,653
Sex	1,527	0,108	4,606	0,717-29,601
Employment Period	2,511	0,009	12,312	1,867-81,189
Work Load	1,923	0,034	6,844	1,156-40,524

DISCUSSIONS

Some workers experience moderate fatigue. The combination of several factors can lead to fatigue, decreased work motivation, and low work productivity. There are many influencing factors to work fatigue in the fish smoking center in Wonosari Village, one of which is the work environment. Based on the Regulation of Minister of Manpower No. 5 of 2018 concerning Occupational Safety and

Health and Work Environment, the work environment in Fish Smoking Center, Wonosari village has been recorded above the NAB, 30,03°C.²²

The workers at fish smoking centers conduct combustion as a production process. The combustion process will increase the room temperature and workers' body temperature. If the body temperature increases, the hypothalamus in the brain will stimulate the sweat glands. Excessive sweating causes lacks of the body fluid affecting the level of sodium and chloride in the body. This results in glucose transport which acts as an energy source and the blood supply to organs resulting in a decrease in muscle contraction.³ Longer period of muscle contractions will cause a lack of energy supply and inability to remove metabolic waste, especially lactic acid.²³

Accumulation of lactic acid affects nerve fibers and the central nervous system, causing a person to slow down. Limited blood flow to the muscles during contractions also causes muscles to compress blood vessels. Oxygen supply is reduced so that fatigue occurs.²⁴

The variable of age was stated as not significantly associated with work fatigue. This is due to variations in age data not. shows a significant difference. Not only mature workers are at risk of experiencing work fatigue, but young workers also prone to work fatigue. This finding is in line with previous research conducted in the ceramics industry.³ Skillful senior workers with good nutritional status will be able to work effectively to avoid fatigue.³

The variable of sex does not have a significant correlation with work fatigue based on bivariate analysis (p-value 0,217) and acts as the variable of control in multivariate analysis. The finding is in line with a research conducted to workers of spring roll skin industry in Semarang and a research conducted to nurses in hospital.^{12,24}

For workers of Fish Smoking Center, the work load has been divided according to the power of workers. Women have lighter job responsibilities than men. In addition, workers have flexible break time. Adaptation based on workload can also provide tolerance for the possibility of fatigue felt by the body.

Employment period is significantly correlated with work-related fatigue (p-value 0,031). The finding is in line with a research conducted to the workers of PT. Kalimantan Steel and the workers of spring roll skin industry.^{53,14} For multivariate analysis, the variable of employment period acts as the variable of control.

Workers with long working hours indicate that they have longer activities. Long activities result in stronger muscles because they are more trained. The size of pulmonary ventilation in untrained and trained workers will be similar but workers having longer work experience will breathe more slowly and deeply. This will result in less oxygen needed for muscles, so that with the same amount of

oxygen, muscles will be more effective.¹³ For workers of fish smoking center, the long employment period might cause boredom because the work is monotonous, repetitive, and less ergonomic. Most of the respondents are exposed to abnormal carbon monoxide level or $> 1.0\%$. This can be seen from the measurement of COHb levels carried out by researchers. From the results of data analysis, the exposure to carbon monoxide gas has a significant correlation to work fatigue. This finding is in line with previous research conducted on parking attendants in Semarang and motorbike workshop workers in Pontianak.^{9,26}

Workers of fish smoking industry inhale carbon monoxide during the production process. Smoke is obtained from the combustion of non-carbonated corn cobs. CO can shift oxygen attachment to hemoglobin and then bind Hb to carboxyhemoglobin. This can restrict the distribution of oxygen from Hb to all body tissues. All tissues will bear the impact on COHb including the brain and heart. In conditions of lack of oxygen, carbon dioxide and H⁺ ions are released. To meet the lack of oxygen supply, body conducts an anaerobic process, which produces lactic acid. If lactic acid accumulates, fatigue can occur.^{26,27}

In bivariate and multivariate analysis, workload has a significant correlation with work fatigue. Workload is also analyzed as the dominant variable in the study. This result is in line with previous research on workers in the ceramics industry, workshop workers, and spring rolls skin industry in Semarang.^{3,12,20}

The heavier the workload results in the faster the worker gets tired. Static pressure on muscles for a long-time results in the pain of muscle, bone, and tendon. Under the conditions of static muscle, blood flow will decrease, lactic acid will accumulate and fatigue will occur. Heavy work requires more frequent rest and short working time. If workers should work extra time, they might experience work-related fatigue.^{29,30}

Workers at the fish smoking center tend to have less rest periods because of the demand to achieve maximum results. High temperature at working area and repetitive and less ergonomic working attitude increase the work load. Workers with high workload are prone to work fatigue 12 times higher after being controlled by the variables of sex and employment period.

CONCLUSION

1. Half of the respondents were under 35 years old, and most of the respondents were female workers, have worked for less than 5 years, had medium work load and are overexposed to carbon monoxide
2. The variables of sex and employment period aren't significantly related to work-related fatigue ($p < 0,05$)
3. Variable that are significantly related to work-related fatigue are employment period ($p = 0,031$), work load ($p = 0,007$) and exposure to Carbon Monoxide ($p = 0,009$)

4. The variable of work load is known as the dominant variable

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CONFLICT OF INTEREST

There was no conflict of interest in this study

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ETHICAL CLEARANCE

Ethical review was conducted in accordance with the procedures at the Faculty of Public Health in Diponegoro University.

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