

Relationship of Noise Intensity, Heat Stress, and Physical Workload to Workers' Health Complaints at Semarang Timber Factory

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ABSTRACT

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Background: As a country with a developed industry, the majority of entrepreneurs in Indonesia use modern industrial tools to help make their work easier. However, using modern technology causes side effects, such as noise from machines that cause hearing complaints. In addition, the hot work environment causes discomfort during work, and the excessive physical workload makes workers experience health complaints. **Methods:** This quantitative research uses a cross-sectional study approach with a purposive sampling technique. The sample consisted of 60 workers from a total of 126 in a wood factory in Semarang. The research instrument is a health complaint questionnaire sheet and a noise (a sound level meter), a physical workload (an oximeter), and a heat pressure (the QUESTemp). Data was analyzed by univariate and bivariate using the chi-square test. **Results:** The highest noise intensity is 98.02 dB, the highest heat pressure is 33.4°C, and the majority of the physical workload felt by workers is in the medium category. The chi-square test shows a relationship between noise intensity, heat stress, and health complaints of workers in a Semarang wood factory ($p < 0.05$). Meanwhile, physical workload has no relationship with the health complaints of workers at the Semarang wood factory ($p > 0.05$). **Conclusion:** Semarang wood factory has noise intensity and heat stress exceeding the threshold value, and most workers experience moderate physical workloads. The company should direct control of workers through the use of personal protective equipment and adequate drinking water, as well as controlling physical workloads on workers with workplace stretching exercises.

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1. Introduction

Noise is any unwanted sound produced by production and work equipment that can cause health complaints such as hearing [1]. The ear's sound stimuli can cause an uncomfortable ringing sensation [2]. Noise Threshold (NAV) value of 85 dBA as noise intensity that is still acceptable to workers and does not cause disease or health complaints at work for a period of no more than 8 hours per day or 40 hours a week has been regulated in the work environment safety and health regulation [3]. Noise can cause workers to have difficulty communicating and interfere with the hearing system [4].

Working environment temperatures that are too high pose a hazard to workers' health, ranging from discomfort and changes in physical and mental appearance to the development of severe health problems. Hot temperatures cause fatigue, and lethargy, reduce work performance and

increase the risk of errors in work [5]. In addition, a hot work environment can slow down work, affect the efficiency and performance of workers, and have an essential effect on the workload experienced by workers [6]. The Occupational Safety & Health Administration (OSHA) describes work involving high air temperatures, heat radiation, high humidity, physical contact with hot objects, or strenuous physical activities that can cause stress. Heat stress is a physical factor that can cause a disturbance under certain conditions. Heat stress can also be said to be a limitation of the body's ability to receive heat exposure from a combination of body heat at work or environmental factors (such as air temperature, humidity, direct sunlight, wind movement, heat radiation transfer, and air movement heat transfer) and the clothes worn and the degree of acclimation [7]. Exposure to excessive heat stress can cause heat-related symptoms or diseases due to heat exposure such as dehydration, heat cramps, heat rash, heat stroke, and heat exhaustion. People with a history of exposure to hot environments with some exertion at work are usually more susceptible to heat exhaustion. Patients with heat exhaustion will usually experience excessive sweating, dizziness, thirst, weakness, headache, malaise, fatigue, blurred eyes, increased pulse, low blood pressure, fainting, and increased body temperature [8].

Perseroan Terbatas (PT) Makin Makmur Santosa is a wood factory engaged in the production process with the workflow of cutting, heating, drying, printing, and distributing wood. The company produces 100 pieces of wood daily and is located in Semarang. Based on a preliminary study at the Semarang Timber Factory, it is known that the work is carried out for six days, Monday to Saturday, with a working time of 8.5 hours from morning to evening, with a break of 1 hour. This is not in accordance with Job Creation Law No. 11 of 2020, so it can endanger the safety and health of workers. Based on data from the internship results, there are significant hazards and risks at the Semarang Timber Factory, namely noise with a prevalence of 70% having experienced disturbances, heat stress with a prevalence of 75% experiencing complaints, and a high workload. It can be seen from workers who experience many complaints of hearing loss, concentration problems, emotional disturbances, sleep disorders, communication disorders, body pain disorders, dizziness, increased body temperature due to being in a place exposed to noise, heat stress, and heavy workloads. In addition, the number of complaints from workers obtained from the results of internships shows the noise in PT. Makin Makmur Santosa is 89.7 dBA and the heat pressure is 33°C. It is not in accordance with the guidelines for occupational safety and health in the work environment regulation because it has exceeded the threshold value that should have been. Supposedly with a working length of 8 hours, workers cannot receive noise of more than 85 dB, while for heat stress or ideal temperature with a workload of 8 hours per day, that is 28°C [9]. Therefore, the researcher aimed to analyze the relationship between noise intensity, heat stress, and physical workload on the health complaints of workers in a wood factory in Semarang.

2. Materials and Method

This research is quantitative research with a cross-sectional study approach. The research data was collected from December 27, 2021, to January 7, 2022, at the PT. Makin Makmur Santosa, Semarang. The population taken is all wood factory workers at PT. Makin Makmur Santosa, Semarang, totaling 126 workers and using the purposive sampling method to take research samples. It is due to limited human resources, time, material, and the number of workers, which is more than 100 workers, and using purposive sampling can produce a sample logically representing the population. In addition, this study has inclusion criteria, namely the respondent works in the oven, sawmill, and vacuum section in a wood factory, the respondent has worked for at least one year and the respondent is willing to be asked for information. While the exclusion criteria are respondents are not working or retired, or have died. The sample used by researchers is as many as 60 workers. The independent variables in this study are noise, heat stress, and physical workload. At the same time, the dependent variable is health complaints.

This research instrument uses a questionnaire sheet to determine workers' health complaints, a sound level meter to measure noise intensity in units (dB), and a tool to measure physical workload in the form of an oximeter with units (%) referring to the Encyclopedia of Occupational Health and Safety. ILO. Geneva, and the thermal pressure gauge, QUESTemp with units (°C). The

data analysis used by the researcher is univariate analysis to determine the frequency distribution of each variable and bivariate analysis to examine the relationship between the independent and dependent variables. This study uses the chi-square statistical test because this study's analysis uses categorical variables and examines the relationship between independent and dependent, and this study does not have confounding variables. This study was declared to have passed ethical approval by the health research ethics commission with No: 413/EA/KEPK-FKM/2021, which was published on December 24, 2021.

3. Results and Discussion

3.1. Results

Table 1 shows that most of the workers are male (88.3%), with ages 36-45 years (40%), have been working 11-20 years (45%), and have their last education was senior high school (65%). The workers exposed to the highest noise were 44 people (73.3%), and the highest heat stress was 44 people (73.3%). Then the work activities of workers in the Semarang wood factory are the majority of moderate physical workloads, which are 26 people with a percentage (43.3%), and based on research results show that 41 workers experience health complaints at the Semarang wood factory with a percentage (68.3%).

Table 1. Respondent Characteristic

Variables	f	%
Gender		
Male	53	88.3
Female	7	11.7
Age (years)		
<26	11	18.3
26-35	6	10.0
36-45	24	40.0
46-55	19	31.7
Work (years)		
1-10	26	43.3
11-20	27	45.0
21-30	7	11.7
Education		
Elementary school	10	16.7
Junior High School	11	18.3
Senior High School	39	65.0
Noise		
High	44	73.3
Low	16	26.7
Heat Stress		
High	44	73.3
Low	16	26.7
Physical Workload		
Heavy	20	33.3
Moderate	26	43.3
Light	14	23.3
Health Complaint		
Exist	41	68.3
Does Not Exist	19	31.7

Table 2 shows that from the statistical results of the chi-square test on the noise and heat stress variable p-value <0.05 or significant. So it can be concluded that the intensity of noise and heat stress is related to workers' health complaints in the wood factory Semarang. In contrast, the physical workload got a p-value >0.05 or insignificant, which means there is no relationship between physical workload and health complaints at the Semarang wood factory.

Table 2. Bivariate Analysis Results

Variables	Health Complaints		P	OR (95% CI)
	Exist	Does Not Exist		
Noise				
High	27 (65.9%)	17 (89.5%)	0.049	4.407 (0.889 – 21.853)
Low	14 (34.1%)	2 (10.5%)		
Heat Stress				
High	27 (65.9%)	17 (89.5%)	0.049	4.407 (0.889 – 21.853)
Low	14 (34.1%)	2 (10.5%)		
Physical Workload				
Heavy	15 (36.6%)	5 (26.3%)	0.087	Unknown
Moderate	14 (34.1%)	12 (63.2%)		
Light	12 (29.3%)	2 (10.5%)		

3.2. Discussion

Noise is one of the factors that can affect the occurrence of health complaints. Noise is a sound that is disliked, disturbing sound, or sound that is not wanted by humans [10]. If the noise continues daily and for a long time, it can cause hearing and non-hearing disorders [11]. It happens in the Semarang wood factory, which is issued by industrial machines continuously and can cause disturbances or human health complaints [12].

From the results of research at the Semarang wood factory PT. Makin Makmur Santosa, most of the workers are male (88.3%), with age 36-45 years (40%), have been working 11-20 years (45%), and have their last education were senior high school (65%) (Table 1). By using a sound level meter, it is known that the highest noise intensity is 98.02 dB while the lowest is 48.00 dB. In addition, it is known that respondents who work with a noise intensity of 48.00 dB as many as 16 workers (26.7%), which comes from a wood vacuum machine to reduce moisture and fiber content in wood, and respondents who are exposed to noise with an intensity of 98.02 dB as many as 44 workers (73.3%) which comes from a wood-cutting machine called a benso and a boiler machine.

By using the chi-square statistical test table to measure the relationship between noise intensity and health complaints, it can be seen that 27 workers (65.9%) experienced health complaints above the threshold (>85 dB), and 17 workers (89.5%) did not experience them. With exposure to noise (<85 dB), there were 14 workers (34.1%) who had health complaints and two workers (10.5%) without health complaints. It shows that a p-value of 0.049 was obtained based on statistical results using the chi-square test, meaning that statistically, it rejected the Ho belief that there was a relationship between the noise variable and the health complaints of workers at the Semarang Timber Factory.

These health complaints are caused by noise levels that exceed the threshold for 8-9 hours in a row per day. In addition, it is also caused by the working time from Monday to Saturday, which is not in accordance with the Job Creation Law no. 11 of 2020, and exposure to noise in the Timber Factory, which indeed exceeds the threshold value set by the Regulation. The longer a person is exposed to high noise levels, the more likely that person is to have hearing and non-hearing disorders or complaints [13]. Non-hearing complaints include lack of concentration, discomfort, headaches, irritability, stress, fatigue, communication disorders, and anxiety [14]. Another cause of many workers experiencing health complaints is the non-use of ear protective equipment.

Health complaints that workers at the Semarang wood factory can feel include dizziness, headache, nausea, shortness of breath, earache, cramps, lack of focus, or loss of concentration which can indirectly endanger the safety of workers. In addition, many workers experience

communication disorders, where workers have to shout while speaking, and conversations are difficult to understand. It can cause accidents and PAK [15]. A noisy work environment can sometimes interfere with worker productivity levels [16]. This is due to a mismatch between abilities and worker limits. This is very influential on work productivity [17].

With many health complaints from workers, the leadership of a Semarang wood factory company provides personal protective equipment, as well as provides education about the importance of using personal protective equipment such as ear plugs, making a policy of using ear plugs in high noise areas because they can reduce noise exposure by 15-25 dBA., a reward and punishment system for workers who violate existing safety regulations, as well as controlling noise sources, namely production machines, by carrying out routine maintenance according to regulation is adjusted to the conditions and capabilities of the company [13].

Heat stress is a combination of three factors, namely environmental factors, work factors, and workwear factors. As a result of heat exposure, the body will respond physiologically to dissipate heat by increasing core body temperature, heart rate, and sweating [18]. Another consequence is the emergence of other health complaints such as feeling tired, thirsty, nauseated, dizzy, excessive sweating from the body, flushed skin, and muscle spasms while working [19]. High heat stress can also cause overstress and heat metabolism in the body, so workers can potentially experience fluid deficiency due to excessive sweating, which affects the status of dehydration [20]. It happened at the Semarang wood factory and needs serious attention because the workers' second home is the workplace.

From the measurement of the heat stress of workers at the Semarang wood factory using Questamp 34, it was found that the highest environmental temperature in that place was 33.4°C in the oven and sawmill area, while the lowest ambient temperature was 24.7°C in the vacuum. From these results, it is known that respondents who work with heat pressure below the threshold value of 24.7°C as many as 16 workers (26.7%), namely in the vacuum section, and respondents who work with heat pressure exceeding the threshold value of 33.4°C as many as 44 workers (73.3%) in the oven and sawmill and work activities with a working time of 8.5 hours a day and a working period of 6 days. It shows that the temperature generated in the workplace exceeds the permissible threshold value, and in daily activities, workers can experience a lack of fluids in the body, and body temperature increases [21].

The recommended workplace temperature in the workplace is 24-26°C (dry temperature) at a humidity of 85%-95% and a wet temperature between 22-30°C; the temperature is a temperature that is considered comfortable for the people of Indonesia [22]. Work in the wood factory industry is a type of work with a moderate workload; the allowable threshold value for working time is 75%-100%, which is 28°C [1]. If the workforce works in a workplace with heat stress exceeding the threshold value, it can experience the impact of heat stress. The effect of heat stress occurs due to the body's metabolism in maintaining body heat which does not work, namely in the form of sweating [21].

Based on the relationship between heat stress and health complaints with the chi-square test, it can be seen that 27 workers (65.9%) experienced health complaints with exposure to heat stress in the work environment that exceeded the threshold value (>28°C), while 17 workers (89.5%) others do not. Workers who are exposed to heat stress in the work environment below the threshold value (<28°C) who experience health complaints are 14 people (34.1%), while those who do not experience health complaints are two people (10.5%). Based on the statistical results using the chi-square test, a p-value of 0.049 was obtained, which means that there is a relationship between the heat stress variable and the health complaints of workers at the Semarang Timber Factory.

These health complaints are caused by exposure to environmental heat above 28°C, which is not following regulation [13], which is the temperature allowed for moderate workloads with a working time of 75% - 100% for 8 hours per day is 28°C, and also the work is carried out with a working time of 8.5 hours a day, and the length of work is six days, workers also do not use personal protective equipment. It, of course, impacts workers' health because of the excessive time and the risk of working in hot places, which can make workers dehydrated and exhausted [23].

Health complaints caused by the heat stress of the working environment at the Semarang wood factory include workers getting tired quickly, tired, thirsty, body aches, headaches, skin itching, skin rashes, excessive sweating, and cramps. It can cause heat stroke, heat cramps, heat exhaustion, dehydration or lack of fluids in the body, experiencing complaints of higher body temperature, which can affect the safety and health of workers [24].

For this reason, workers need to be provided with drinking water in the workplace that has been given sufficient salt, such as electrolyte solutions (sodium and potassium), so that workers get a fluid supply to replace lost body fluids and maintain their health condition of workers [18]. In addition, proper or sufficient rest will be excellent. To minimize the occurrence of disease complaints in the Semarang wood factory, it is necessary to provide sufficient personal protective equipment for workers exposed to heat sources either directly or indirectly because personal protective equipment can reduce the risk of exposure to danger or disease [22].

The workload is an activity that requires the ability and expertise to do mandatory things in the form of physical and psychological within a particular time [25], and any work that requires muscle strength and the subject's thinking [26]. The workload is the amount of work that must be done, and completed by a person, either individually or in a team, between the amount of work volume and working time [27]. However, the workload also needs to pay attention to and adjust the physical and psychological abilities of workers so as not to affect their health conditions of workers [28]. If not, there will be an impact from an excessive workload, namely physical and mental health complaints and reactions such as headaches, fatigue, body aches, tingling, body aches, unfocused, and irritability. Therefore, the workload is also an ergonomic factor apart from the work position or workstation [29].

There are light, moderate, and heavy categories based on the measurements using an oximeter. Based on table 4.3, workers at the Semarang Timber Factory have a light physical workload of 14 people (23.3%), a moderate physical workload of 26 people (43.3%), and a heavy physical workload of 20 people (33.3%). Based on these results, it can be concluded that most of the workers' physical workload at the Semarang Timber Factory is moderate physical workload. From the research results, the work carried out by workers at the Semarang wood factory is pushing, bending, lifting wood, and often standing, which is done repeatedly. The work is carried out with a duration of 8-9 hours a day and six days of work a week. It can affect the physical and mental conditions of workers because they are not in accordance with the Law on Job Creation. 11 of 2020 and working time of 75%-100%, which should be for medium workloads at the Semarang wood factory [13].

Based on the correlation test results between physical workload and health complaints of workers at a wood factory in Semarang with a chi-square statistical test, a p-value of 0.087 was obtained, which statistically there was no relationship between the physical workload variable and health complaints of workers. The table also shows that 12 people (29.3%) experienced health complaints with light physical workloads, 14 people (34.1%) had moderate physical workloads, and 15 people (36.6%) had heavy workloads. Meanwhile, in the category of not experiencing health complaints, there were two people with a light physical workload (10.5%), 12 people with a moderate physical workload (63.2%), and five people with a heavy physical workload (26.3%). Based on statistical tests, there is no relationship, but many workers experience health complaints. Physical and mental health complaints experienced by Semarang wood factory workers were headaches, body aches, dizziness, tingling, muscle spasms, chest pain, shortness of breath, fatigue, and lethargy. It can pose a risk of occupational accidents that will impact work productivity at the Semarang wood factory.

One of the factors that cause or affect the physical workload that can cause health complaints is the demands of the tasks given by the company to workers so that they are immediately resolved and achieve the targets set by the company [30]. The workload with many or few tasks assigned to workers will also affect the performance of workers [31] and the length of work time given by the Semarang wood factory, which exceeds 40 hours a week or more than five days. If so, the company should determine the length of a person's work according to the workload obtained with his ability so that workers can carry out their work without experiencing health complaints because

the heavier the workload, the shorter the work time [32]. To prevent health complaints, Semarang wood factories need to make policies regarding adequate rest periods, suitable types of work, using technology to lighten the workload, and educating workers at Semarang wood factories to stretch for 5-10 minutes just before work, during breaks, and after work. In addition, it is necessary to conduct health checks for workers according to the needs and capabilities of the company.

4. Conclusion

Semarang wood factory is an industry that is engaged in cutting, drying, and printing wood with noise intensity and heat stress exceeding the threshold value, and most workers experience moderate physical workloads. For this reason, companies need to control noise, and heat stress both at environmental noise and heat sources, control administratively and directly workers by requiring the use of personal protective equipment, provide adequate drinking water, and make policies or programs to control physical workloads for workers as promotive and preventive measures against health complaints of workers in a wood factory in Semarang.

Declaration

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