The Analysis of PM¹°Dust Exposure to the Labors Capacities' Lungs in the Wooden Furniture Industry

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Abstract: *This paper examines the correlation between exposure to wood dust, especially PM¹°, and decreased lung function. The effects of inhalation of particulate dust (PM¹°) have been widely studied in humans, plants, and animals. Issues of the impact include an increase in people with asthma and lung cancer and premature death. The research was done in August - December 2019 in three wood furniture industries in Pesisir Selatan Regency. This research is the main task and function of the author as a form of community service in occupational safety and health service activities. This study uses quantitative methods using the Chi-Square test. but, for other variables (age and years of service with impaired lung function) logistic regression analysis was used. The statistical analysis of the data shows that there is a significant relationship between the concentration of PM¹° and lung function in labor as seen from the FEV1 and FVC values between before and after work. Testing PM¹° concentration in furniture labor is carried out early so that it does not progress to Chronic Obstructive Pulmonary Disease (COPD).*

Keywords: *Particulate Matters PM¹°, Lung Capacity, Furniture.*

INTRODUCTION

A good and healthy living environment is a human right and a constitutional right for every Indonesian citizen. Therefore, the state, government, society, and all stakeholders are obliged to protect and manage the environment in the implementation of sustainable development. One of the goals of the Sustainable Development Goals (SDGs) is industry, innovation, and infrastructure that are expected to reduce poverty, equitable sustainable development, livelihoods, and decent work, with several target indicators for the elimination of hunger, poverty alleviation, health and equality, resilient infrastructure, inclusive and innovative industries (SDGs, 2017).

The wood processing industry is one of the industries that is growing very rapidly, this is related to the consumption of forest products which reaches 33 million m_3 each year. Such a large consumption of forest products is absorbed by the plywood, sawmill, furniture, particle board, and paper pulp industries. These industries have the potential to cause contamination in the workplace air in the form of wood dust. It is because about 10 to 13% of sawed wood will be wood dust (Suryani & Setiani, 2005).

Industrial development results in decreasing in air quality and causes air pollution in the world (Ahmad, 2014). Furniture sector jobs use various types of wood as raw material/main. One of the dangerous factors of furniture work is wood dust which is generated through mechanical processes

such as sawing, shrinking, grinding, and sanding. Wood dust in the air can be inhaled into the respiratory tract and settles in various places in the respiratory organs. Risks to health from dust exposure include short-term inflammation of the respiratory tract with symptoms of cough with phlegm, runny nose, fever, and eye irritation. Dust generated from various work processes can pollute industrial areas and the surrounding environment so that workers and communities around the industry can be exposed to dust either because of raw materials, intermediates, or final products, the case of contaminated materials can affect the environment and humans (Maywati, 2014).

The furniture/wood furniture industry in Pesisir Selatan Regency is often found and is included in the small industry group with several laborers between 5 - 15 people. The existence of activities in the wood furniture industry has an impact on the environment, workers, and society and then creates a risk of health problems for workers and the community if no control is carried out either at the source or the workers themselves. The wood furniture industry in Pesisir Selatan Regency has not been supervised by the local Public health center so environmental pollutant parameters and environmental inspections have never been carried out.

Therefore, through the labor inspection program with inspection of the work environment, the authors tested PM¹° dust levels in 3 furniture industries, namely Pondok Jati Anisa, Painan Karya Furniture and Furniture Engineering Works, and analyzed the effect of PM¹° dust on decreasing lung function of workers.

METHODS

This type of research is quantitative with a cross-sectional research design, which means that the dependent variable and the independent variable are examined simultaneously or simultaneously at one period or one time. The independent variable (free) is particulate PM¹° and the dependent variable (dependent) is the lung capacity of all workers in the 3 wood furniture industries.

This study uses primary data which is taken by the researcher through direct observation and interviews with the object of the researcher. Observation and measurement, namely measuring PM¹° dust in the furniture industry and measuring spirometry for the worker's lung function (Farida , 2016). Examination of the worker's lung function capacity is carried out by taking the values of Forced Vital Capacity (FVC), Forced Expiratory Volume in One Second (FEV1), and FVC/FEV1 Ratio. The results obtained are interpreted according to the following Table 1 below.

Table 1. classification of lung fungtion disorders

Restriksi FVC/PRED (%)	Classification	Obstruktif FEV 1/FVC (%)
> 80	Normal	> 75
60 – 79	Mild	60 – 74
30 – 59	Moderate	30 – 59
< 30	Severe	< 30

Table 2. Operational definition

Variable	Operational definition	Measuring instrument	Way Measurement
Pulmonary function disolders	Pulmonary function conditions were assessed using the percentage parameter *Forced Vital Caoacity* (FVC) and *Forced Expiratory Volume in One Second* (FEV1) each FCV.	*Spiro Analytes* ST-75, Fukuda Sangyo brand	Measurements using a Spirometry tool. Direct Reading Analysis
PM¹°	Measurement of particulate	*EPAM 5000*	Measurements

Variable	Operational definition	Measuring instrument	Way Measurement
Particulate	work environment PM^{10} is assessed using the Threshold Value (TLV) 3 mg/m³. Minister of Manpower Regulation No. 05 of 2018	*(EnvironmentalParticle Air Monitor) Haz – Dust Personal Dust Sampler* (PDS) Grilliant HF ATR-S-230V AC.	using the EPAM 5000 tool. Time Weighted Analyst (8 hours of work)

Data analysis was carried out with bivariate analysis to know the relationship between air quality in the work environment (PM^{10} particulate exposure) and lung function disorders in workers in the wood furniture industry using the Chi-Square test. This test is used because the data analyzed is categorical. To see the meaning of the results, statistical calculations are used (the limit of significance with $\alpha = 0.05$) so that if a statistical analysis is found with a P value of <0.05, the relationship between the two variables is declared significant. Meanwhile, for other variables (age and years of service with impaired lung function) logistic regression analysis was used.

RESULTS AND DISCUSSION

3.1 RESULT

The wood processing/furniture industry in Pesisir Selatan Regency is in the middle of community settlements, so dust particles from this wood processing activity can not only be inhaled by workers but also have the potential to reduce air quality which can cause health problems to the community around the industry. There are several parts in each wood processing industry that have implications for the different levels of wood dust produced by each section (Anugerah, 2018) as follows:

1. Sawmills, this section produces coarse and fine dust sizes with various particle sizes.

2. Assembling and Forming, this section uses manual and mechanical equipment and is likely to produce less dust.

3. Sanding, sanding coarse and fine manually or using a machine that produces fine dust (respirable) if inhaled will accumulate in the lungs.

4. Furniture Finishing, forging, and painting furniture is done. Painting is done manually and also with a spray machine/spray which produces fine particles suspended in the air.

Air is an important factor in life, but with the increasing physical development of cities and industrial centers, air quality has changed. Changes in the air environment are generally caused by air pollution, namely the entry of pollutants (in the form of gases, small particles/aerosols) into the air. The entry of pollutants into the air is partly caused by human activities such as transportation, industry, garbage disposal, and household activities (Soedomo, 2014).

PM^{10} is a solid and liquid particulate that floats in the air with a medium value of 10 microns aerodynamic diameter. 10-micron particulates have several other names, namely PM^{10} as inhalable particles, respirable particles, respirable dust, and inhalable particles. According to WHO 1996, the size of hazardous dust particles is 0.1-5 or 10 microns in size. The Ministry of Health indicates that the size of the dust that is harmful is 0.1 to 10 micron (Darmawan, 2013). Based on the regulation of the Minister of Manpower and Transmigration Number 05 of 2018 concerning Occupational Safety and Health in the Work Environment, the threshold value for respirable particulates is 3 mg/m³. 9

Research on the effect of PM^{10} dust on the lung function of workers was carried out in 3 wood furniture industries in Pesisir Selatan Regency according to Table 3 below.

Table 3. Distribution of sample location and number of respondents

Location	The number of workers (person)	Respondent (person)
Pondok Jati Anisa	13	13
Painan Karya Furniture	10	10
Karya Teknik Furniture	13	13
Total	36	36

Examination of lung capacity/lung function is carried out on all workers in the 3 furniture industries because this industry is a small and medium industry group where health checks for workers and their work environment are not yet an obligation because there is no inspection and supervision or environmental audit required for industries - this small and medium category of industry. Meanwhile, this can have an impact on the environment and public health in a certain period of time, so it is necessary to carry out a medical examination of all workers in the wood furniture industry. The results of PM¹° measurements in the air work environment in the wood furniture industry can be seen in Table 4 below.

Table 4. PM¹° Dust Concentration in the Wood Furniture Industry Work Environment

Sample Location	Average Concentration (mg/m³)	Threshold Value (mg/m³)
Pondok Jati Anisa	8,48	10
Painan Karya Furniture	9,37	10
Karya Teknik Furniture	8,28	10

Based on Table 4 above, the concentration of PM¹° dust particles in the three industries is almost close to the threshold value. Although it has not exceeded the standard for dust in the work environment, it is necessary to look at the concentration of inhalable PM¹° dust particles inhaled by labor with a Threshold Value (TLV) of 3.0 mg/m³ as in Table 5 below.

Table 5. Distribution of Respondents who inhaled PM¹° particles

Location	Respondent (person)	fulfill the standard, NAB (person)	Not fulfill the standard, NAB (person)
Pondok Jati Anisa	13	11	2
Painan Karya Furniture	10	6	4
Karya Teknik Furniture	13	12	1
Total	36	29	7

Table 5 or meet the standard are 29 people (80.56%) while those who do not meet the standard or exceed TLV are 7 people (19.44%) in accordance with standards recommended by the Minister of Manpower and Transmigration Regulation Number 5 of 2018 concerning Occupational Safety and Health (K3) Work Environment. Based on the examination of the lung function capacity of all workers in the furniture industry above, the results are as shown in the following Table 6 below.

Tablel 6. Distribution of respondents' lung function disorders

Respondents Lung Function Disorders	F	%
Normal	23	63,89
Having Disorders	13	36,11
Total	36	100

It can be seen from table 4 that tne numbers of labors who do not experience lung function disorders is 23 people (63.89%) and experience lung function disorders in the form of a decrease in the capacity of mild restructured lung function is 13 people (36.11%).

Table 7. Relationship of work environment air quality, PM¹° dust exposure with disorders of worker lung function capacity

PM¹° particulate levels	Lung Function Capacity				Amount	OR (95% C I)	P Value
	Having Disorders		Normal				
	Amount	%	Amount	%			
Not fulfill NAB standard	5	71,83	2	28,17	7	14,825	0,015
Fulfill NAB standard	8	27,59	21	72,41	29		
Total	13		23		36		

The results of the analysis of inhalable PM¹°dust exposure on the lung function capacity of the wood furniture industry workers found that 5 respondents (71.83%) had lung function disorders at PM¹° dust concentrations exceeding the recommended threshold value and 8 respondents (27.59%) having impaired lung function at the PM¹° dust concentration meets TLV standards. Respondents of normal lung function or no decrease in lung function due to exposure to PM¹° dust were 2 people (28.17%) for dust above TLV and 21 people (72.41%) for dust that met TLV standards.

The results of statistical tests obtained p value = 0.15, which means that the P value <alpha (0.05), it can be concluded that there is a significant relationship between the quality of the working air environment for PM¹° dust exposure and lung function disorders in workers. The result of the OR (Odss Ratio) value is 16.825, thus it can be said that respondents who are in dust locations with concentrations exceeding the threshold value have a risk or risk 14.625 times the risk of experiencing lung function disorders compared to respondents who are in locations below the threshold value.

3.2 DISCUSSIONS

The source of potential activities that produce PM¹° dust comes from the production activities of processing wood into furniture, including the sawing process, the sanding process, and the painting process. According to Soedomo (2014), it is explained that the type of wood product industry with the nature of sawing activities, plywood, and furniture boxes causes air pollution problems in the form of fine sawmill dust, paint and solvent, smoke and so on (Sandberg, 2016). From the effect of inhalable PM¹° dust exposure on the lung function capacity of the wood furniture industry workers, it was found that 5 respondents (71.83%) had lung function disorders at PM¹° dust concentrations exceeding the recommended threshold value and 8 respondents (27.59 %) have impaired lung function at the PM¹° dust concentration that meets TLV standards. Respondents with normal lung function or no decrease in lung function due to exposure to PM¹° dust were 2 people (28.17%) for dust above TLV and 21 people (72.41%) for dust that met TLV standards.

However, other things can also cause lung problems, including increasing the age of a person, and disease susceptibility will increase, especially respiratory disorders in the workforce. Besides the age of the workers, one thing that can affect lung disorders is the working period. This is also explained by Bapino et al (2014) who state that the length of exposure to air pollution which can reduce the vital capacity of the lungs takes about 20 years. Based on the logistic regression analysis, it was also known that age and years of service also affected lung function disorders.

The main lung function is the process of respiration, which is the taking of oxygen from the outside

air which enters the airways and continues into the blood. In addition to assessing the condition of the lung organs, a diagnosis of lung disease also needs to determine its functional condition by knowing the state of lung function, because the presence of gas or dust particles that enter and settle in the lungs and other air pollutants can cause lung function disease. Air pollution can lead to pneumonia if this happens continuously.

The age factor affects lung elasticity as well as other tissues in the body. Although the relationship between age and lung volume fulfillment cannot be detected. The dust has a long enough half-life in the lungs for it to accumulate. The long working period allows the accumulation of dust in the lungs to also increase because it has inhaled air contaminated by the dust. The working period tends to be a risk factor for obstruction of workers in industries that are exposed to dust for more than 5 years.

CONCLUSIONS

The results of research from 3 furniture industries in Pesisir Selatan Regency for the measurement of the total dust in their work environment are almost close to the Threshold Value (TLV) so it is necessary to test PM¹° dust particles inhaled by laborers. The PM¹° inhalable dust test results show that there is dust exposure that exceeds the inhaled standard by the laborers which can cause lung function disorders. Of the 36 respondents, inhalable PM¹° dust measurements were obtained, and the results showed that the PM¹° dust concentration exceeded the TLV by 7 people. Meanwhile, for the examination of lung function, 36 respondents found that 13 people had lung function disorders. From the results of statistical data, there is a significant relationship between PM¹° dust concentration in the work environment on the lung function capacity of workers in the wood furniture industry.

ACKNOWLEDGMENTS

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