



The Determinant of Lung Function Disorders of The Textile Industry Spinning Section

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Abstract

Many factors affect lung function capacity in textile industry workers. This research aims to determine the factors that affect the vital role of pulmonary spinning workers in the textile industry. This research used an analytic observational research design with a cross-sectional approach. The sampling technique used total sampling and getting the sample was 96 people, and measurement of lung vital capacity used spirometry. The Low Volume Sampler was applied to measure dust concentration, and the questionnaire was used to assess the individual characteristics. Bivariate analysis of the variables is the working environment dust, exercise habits, smoking behavior, and gender are significant. The result of multivariate analysis of dust is the most affecting to the lung vital capacity. In conclusion, dust concentrations are classified above the Threshold Limit Value (TLV), so the company should control the source of dust exposure.

Introduction

Occupational respiratory disease is a major global public health problem that accounts for up to 30% of all occupational diseases. Besides, 10-20% of deaths are caused by respiratory disorders (Gizaw et al., 2016). Exposure to dust in textile industry workers can be at risk of causing lung function disorders. Health effects, in the form of impaired lung function, have been documented in workers exposed to dust in both small, medium, and large industries (Subbarao et al., 2009). Occupational Lung Disease (OLD) is a pulmonary disease arising from prolonged or repeated exposure that causes toxic effects, both acute and chronic (Stobnicka and Górný, 2015). Occupational diseases are caused by pathological responses from patients to their working environment (Qian et al., 2016). There is a growing consensus on the adverse impact of organic dust on the symptoms and respiratory

function of industrial workers, one of which is impaired lung function (Khodadadi et al., 2011).

ILO shows that annually there are more than 250 million accidents at workplaces. While 160 million workers become sick due to hazards in the workplace. Also, around 1.2 million workers die due to accidents and occupational diseases. New materials for the production process are distributed annually in the workplaces, and many of them cause lung disease (ILO, 2013). Indonesia is one of the developing countries with many companies producing dust from the production process. OLD is a group of occupational diseases in which the target organ of the disease in the lung (Sumakmur, 2014).

The textile industry is one of the many vital sectors in Indonesia, especially in the Surakarta Raya region. Workers can be exposed to a variety of different environmental factors,

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especially from the spinning and weaving processes (Wami et al., 2018). Those processes in the textile industry produce large amounts of cotton dust (Tagiyeva et al., 2017). The dust consists of various sizes and types of particles, such as plant materials, fibers, bacteria, fungi, soil, pesticides, non-cotton materials, and other contaminants (Wu et al., 2019). Research on respiratory disturbances and impaired lung function in cotton spinning in Egypt shows a significant relationship in the group exposed to dust (Tageldin, et al., 2017; Wami et al., 2018).

The initial survey conducted at 3 points in the production area of the spinning/spinning industry of the textile industry showed the highest levels of work environment dust of 0.24 mg / m³ and the lowest 0.19 mg / m³ with an average of 0.21 mg / m³. This figure is included above the Threshold Value (NAV) of working environment dust with the type of cotton at work equal to 0.2 mg / m³. The purpose of this study is to determine the determinants of the vital capacity of the lung of spinning textile industry workers.

Methods

This study uses an observational analytic design with a cross-sectional study design. It explains the differences between the variables through testing previously formulated hypotheses. This research approach uses a cross-sectional approach in which cause/risk and causal/causal variables are measured or collected at the same time and carried out at the same time. The study was conducted from November 2017 to July 2018 on the spinning labor section in the textile industry. This study uses a total sampling technique where all workers in the spinning section are assigned to be the research sample. The research sample of 96 workers.

The independent variables in this study were environmental dust and individual characteristics, including age, sex, years of service, exercise habits, and smoking behavior. While the dependent variable was vital lung capacity. The measurement of dust levels in the work environment is carried out at 6 points of the spinning area measured using a Low Volume Sampler (LVS) tool. To get the concentration of dust by using a sample filter

before and after being entered into the LVS. The result is the dust content from the LVS tool. It was then weighed again with analytical scales to obtain the difference in dust after and before measurement. Procedure for measuring environmental dust based on SNI 16-7058-2004 regarding the total dust measurement. Other variables such as age, sex, years of service, exercise habits, and smoking behavior were assessed by a questionnaire.

Pulmonary function tests were carried out on a total of 96 workers in the textile industry spinning section of PT X. Measurements using spirometry are a tool used to determine the percentage of Forced Vital Capacity (FVC) and Forced Expiratory Volume / Forced Expiratory Volume / forced volume in the first second (FEV1) .

The vital lung capacity is classified into four. Namely normal, obstructive, restrictive, and mixed. Based on the % FVC and % FEV1 measured used a spirometer which is a tool used to find out the percentage of Forced Vital Capacity (FVC) and Forced Expiratory Volume / Forced Expiratory Volume / forced volume in the first second (FEV1). Pulmonary function is normal if % FVC \geq 80% and % FEV1 \geq 70% and obstructive disorders if % FVC $<$ 80% and % FEV1 $<$ 70%, restrictive disorders if % FVC $<$ 80% and % FEV1 \geq 70%, mixed disorders if % FVC $<$ 80% and % FEV1 $<$ 70%.

This analysis is to see the description and characteristics of each independent variable and the dependent variable. The variables of this study were analyzed using the frequency distribution of SPSS version 23 data tendencies to describe the characteristics of each study variable. Bivariate analysis is used on two variables thought to have a relationship or mutual correlation. The bivariate analysis uses the Spearman correlation test for work environment dust variables with obstructive, restrictive, and mixed pulmonary function disturbances. Because the independent variable uses a numerical data scale (ratio) and the dependent variable has a categorical (ordinal) data scale.

The relationship strength of a variable is obtained from the direction of the correlation that has positive (+) and negative (-) values. A positive value (+) means that the greater

the value of one variable, the greater the value of other variables. Conversely, for negative values (-). The greater one variable value, the other variables will be smaller. suggests that the correlation strength number (r) is divided into: 1) 0.00 - 0.199: very weak, (2) 0.20 - 0.399: Weak, (3) 0.40 - 0.599: (4) Medium 0.60 - 0.799: (5) Strong 0.80 - 1,000: the significance value of p is as follows: a) If p-value <0.05, the test results have a significant correlation. b) If the p-value is 0.05, the test results have no significant correlation and multivariate analysis to find which variables are the most influential among the variables with a P-value <0.25.

Results and Discussion

PT X textile industry is located on Jalan Raya Solo-Karanganyar km. 9.5, Surakarta, Central Java. The industry has a spinning production unit that produces yarn as a primary material for making fabrics.

Table 1 shows the relationship between respondent characteristics and lung vital capacity. From the age variable, age >40 years has obstructive pulmonary function disorder, restrictive, and mixed. In the BMI variable, the most lung function disorders in respondents with healthy BMI. From the working period, the variable in the period >10 years mostly experience obstructive and mixed lung function disorders. In gender variables, lung function disorders are experienced mainly by men. For the smoking behavior variables, most diseases are the smokers, and for the exercise habits variables, the conditions most occurred on respondents who do not do routine exercise. Correlations between the independent and dependent variables, the age and BMI variables, do not significantly affect the lung's vital capacity, while other variables significantly affect it. The obstructive, restrictive, and mixed pulmonary vital capacity, are theoretically incorporated into disorders pulmonary function.

Table 1. Variable Characteristics with Lung's Vital Capacity

| Variables | Lung's Vital Capacity | | | | Total | r | p-value |
|--------------------------|-----------------------|------------|-------------|-------|-------|--------|---------|
| | Normal | Restriktif | Obstruktive | Mixed | | | |
| Age (year) | | | | | | | |
| 17-40 | 8 | 0 | 0 | 0 | 8 | -0,110 | 0,285 |
| >40-60 | 69 | 15 | 2 | 2 | 88 | | |
| Body Mass Index | | | | | | 0,185 | 0,072 |
| Thin | 6 | 2 | 0 | 0 | 8 | | |
| Normal | 49 | 8 | 2 | 0 | 59 | | |
| Overweight | 14 | 0 | 0 | 0 | 14 | | |
| Obesity | 8 | 5 | 0 | 2 | 15 | | |
| Employment Period (year) | | | | | | 0,236 | 0,020 |
| <10 | 4 | 0 | 2 | 0 | 6 | | |
| ≥10 | 73 | 15 | 0 | 2 | 90 | | |
| Gender | | | | | | 0,319 | 0,002 |
| Male | 30 | 11 | 2 | 2 | 45 | | |
| Female | 47 | 4 | 0 | 0 | 51 | | |
| Smoking Behavior | | | | | | 0,350 | 0,000 |
| Yes | 31 | 12 | 2 | 2 | 47 | | |
| Not | 46 | 3 | 0 | 0 | 49 | | |
| Excercise Habits | | | | | | 0,420 | 0,000 |
| Routine | 64 | 5 | 0 | 2 | 71 | | |
| Not Routine | 13 | 10 | 2 | 0 | 25 | | |
| Dust | Min | Max | SD | Mean | Range | -0,390 | 0,000 |
| | 0,263 | 0,665 | 0,14 | 0,395 | 0,402 | | |

Source: Primary Data, 2018

If we analyze the table for workers > 40 years, they have experienced many lung function disorders. In BMI, workers in the normal and obese categories have lung function disorders, then the working period that workers who have worked ≥ 10 years' experience more lung function disorders than workers who worked <10 years. Female workers have fewer lung function disorders than male workers, smoking habits, and exercise habits according to table

1 shows that smokers and workers who rarely exercise suffer from obstructive, restrictive, and mixed lung function.

Variables, which include in the multi-variate analysis, are variables that have a p-value <0.25. In table 2, the variable most affects the lung's vital capacity is gender, where the four variables above can affect it 38.4% and 52.6% explained by other variables not examined.

Table 2. Variables that Most Affect the Vital Capacity of the Lungs

| Variables | Coefficient β | P-Value | Adjusted R ² |
|------------------|---------------------|---------|-------------------------|
| Dust | -0.290 | 0.001 | 0.384 |
| BMI | -0.348 | 0.000 | |
| Gender | -0.409 | 0.000 | |
| Excercise Habits | -0.175 | 0.040 | |

Source: Primary Data, 2018

Particles that are toxic to magrofag can stimulate the formation of new magrofags. The magrofags formation and destruction continue to play a vital role in the collagen connective tissue formation and the deposition of hyaline in the connective tissue that forms fibrosis. This fibrosis occurs in the lung parenchyma. That is the alveoli and wall interstitial connective tissue. As a result of pulmonary fibrosis will decrease lung tissue elasticity (shifting lung tissue) and give rise to impaired lung development, namely restriction. Obstruction disorder is a pulmonary disorder characterized by barriers to airflow in the respiratory tract that are irreversible. There were three were three respondents (6%) who experienced obstruction. Narrowing of the airways and disruption in airflow therein will affect the work of breathing. FEV1 will always reduce in respondents who experience obstruction. It can be a high amount. Whereas FVC cannot. A mixture of restrictions and obstruction occurs due to pathological processes. It reduces lung volume, capacity, flow, the presence of narrowing of the respiratory tract, and the landfill breathing's presence by particulates.

Measurement of work environment dust at 6 points at PT X Karanganyar, Indonesia Textile Industry obtains an average of 0.395 mg/m³. The analyses in all aspects are above the Threshold Limit Value (TLV) 0.2 mg/m³ every

eight working hours per day for the type of cotton dust based on Permenaker RI No.5, 2018 concerning occupational safety and health work environment appendix 3 TLV Chemical Factors (Republic of Indonesia Ministry of Manpower, 2018). Research by Mwinykione et al. also shows that dust exposure above the threshold value has a risk of decreased lung function (Mwinykione et al., 2005). The workers in the textile industry have the risk of being affected by LFD from exposure to cotton dust. So they can cause the risk of disease. From 96 total samples, 77 workers have normal conditions, and 19 workers experience lung dysfunction (22.86%). Most lung function disorders are the restrictive type, with a total of 15 respondents. The mechanism of dust accumulation in the lung begins by breathing in, then the air containing dust enters the lungs. Dust, between 5-10 microns, will be retained by the upper respiratory tract. The middle will retain the 3-5 microns. Particles with a size between 1 and 3 microns will be placed directly on the surface of the pulmonary alveoli. The particles with a magnitude of 0.1 microns do not so quickly settle on the surface of the alveoli. The mass of dust which is less than 0.1 micron is too small so that it does not end on the surface of the alveoli or lender membrane, because of Brown's movement, causes such dust to move out of the alveoli. The impaired pulmonary

function in the spinning section is also caused by the inhalation of cotton fibers and dust in the working environment (Mahmoud and El-Megeed, 2004). It is consistent with research by Sultan that there was a decrease in lung function against prolonged dust exposure in wood industry workers (Sultan, 2007)

Suma'mur explains that continuous exposure to cotton dust for years irritates the upper respiratory tract of the bronchus. If the exposure continues, chronic obstructive pulmonary disease will happen, which can be interpreted that the more extended the working period, there will be more cotton dust that settles in the respiratory tract, the more severe the disease suffered byssinosis. Invisible cotton dust particles enter the lungs' alveoli through inhalation and accumulate in the lymph causing damage to the alveoli and reducing the capacity to retain oxygen. When cotton dust builds up, workers can suffer from byssinosis (Su et al., 2003). Dust can cause lung disease and fibrosis if inhaled during continuous work. If the alveoli harden, it reduces elasticity in accommodating the air volume so that the oxygen binding ability decreases. The analysis results show that the effect of occupational dust exposure significantly to the lung's vital capacity with a p-value of 0.000. It is in line with research on work environment dust against pulmonary dysfunction (Qian et al., 2016). These results are also in line with Qian's, which shows that there is a relationship between dust exposure and lung function disorder (Su et al., 2003).

Exposure to dust can reduce lung function. This study shows a significant relationship between dust exposure with reduced lung function. It is followed by research; there is a meaningful relationship between workers exposed to dust with lung function disorders where workers exposed to dust have a higher risk than those who do not (Khan et al., 2015; Said et al., 2017). Lung function will decrease as people get older. Age is related to the aging process, where the older a person is, the higher the likelihood of lung function capacity. The age of 20-40 years is the maximum muscle strength in a person and will be reduced by 20% after 40 years old. The older a person is, the risk of impaired lung function is also high (Schachter et al., 2009).

The longer a person is at work, the more he has been exposed to the dangers posed by the work environment, including exposure to cotton dust. Chronic disorders occurred due to occupational dust exposure is quite high. While for an extended period which is usually annual and not infrequently, the symptoms of lung function appear after more than ten years of exposure (Boschetto et al., 2006; Daba Wami et al., 2018). The work period is the length of time worked (years) in a Company environment. The longer a person works in a dusty environment, the further the lung's vital capacity is reduced. For every additional work period in one year, a decrease in lung capacity of 35.3907 ml will occur (Sumakmur, 2014). Research on Lung Morbidity of Traffic Wardens Exposure to Chronic Vehicular Pollution in Lahore Pakistan, involving 500 respondents, concluded that the lung capacity of traffic officers are reduced because of chronic exposure to vehicle emissions (Shelly et al., 2019).

The lung capacity of traffic officers who have a minimum working period of 10 years is moderately affected by 25% of officers and 2.5% of officers who experience a significant impact on the vital capacity of their lungs. The volume and capacity of the entire lung in women is approximately 20 up to 25 percent smaller than men and even higher to athletics and bigger people than people who are small and asthenic. Gender affects lung function disorders. Several pieces of research in the textile industry show that men have a higher risk of lung function disorders than women (Camp, et al., 2004; SchachterI et al., 2009). Other studies have also found that women aged > 50 years are at risk of developing acute respiratory problems due to particulates (Chen and Wu, 2018). Smoking can cause changes in the structure and function respiratory tract and lung tissue. In the large respiratory tract, enlarged mucosal cells (hypertrophy) and mucous glands are multiply. Where the small respiratory tract, inflammation occurs mild to narrowing due to increased cells and mucus buildup. When in the lung's tissue, an increase in the amount of cells inflammation and alveoli damage. As a result of changes in the anatomy of the channel breath, in smokers, changes in lung function and everything kinds of clinical changes (Jaén et al., 2006; KC et

al., 2018). It is the main basis for this chronic obstructive disease. Smoking can accelerate the decline in pulmonary physiology. It may also be caused by male smoking behavior, which makes them easier to experience lung function disorders (Jaén et al., 2006; Bakhsh et al., 2016).

A person's nutritional status affects the body's immune system to maintain personal health from various diseases, such as coughing, colds, diarrhea. Besides, the immune system influences the body's ability to detoxify foreign objects, such as dust that enters the body, which will automatically affect the function and performance of the lungs. A person's nutritional status affects the body's immune system to maintain personal health from various diseases such as coughing, colds, diarrhea, and also the body's ability to detoxify foreign objects such as dust that enters the body. As a result, the function and performance of the lungs also interfere. Besides, the research on obesity and mortality explained that obesity could reduce a person's age. Even obese non-smokers who live healthier lives have a higher risk of premature death than thinner people. One of the assessments of a person's nutritional status is also disturbed by calculating the Body Mass Index (BMI) (Dangi and Bhise, 2017). Lung capacity can be affected by a person's habit of running sports. Exercising can increase blood flow through the lungs so that many causes all pulmonary capillaries to get maximum perfusion. It causes oxygen to diffuse into the pulmonary's capillaries with a greater volume or maximum. Exercising has ten main elements of physical fitness. One of these elements is the function of breathing. Exercise should be done at least three times a week, for athletic people, large bodies, and greater lung volume and capacity. Good exercise can be done at least three times a week. The duration for daily exercise is 20-60 minutes. Lung capacity can be influenced by a person's habit of running sports. Having regular exercises can increase blood flow through the lungs, which will make the pulmonary capillaries get maximum perfusion so that oxygen can diffuse into the capillaries to the maximum (Mohammadien, et al., 2013; KC et al., 2018; Whitsett & Weaver, 2002).

Prevention of the decreased lung function risk can be done by controlling techniques,

treatment, and management aspects. Control techniques by adding ventilation to the work area, covering the risk of dust exposure, using personal protective equipment. In the aspect of treatment carried out with the company providing health facilities and doctors, spirometry examination. As for management aspects, it is work rotation and the existence of clear operational standard procedures related to the prevention of occupational diseases (Boschetto et al., 2006; Portnoy et al., 2012).

Conclusion

There is an effect between exposure to work environment dust with obstructive, restrictive, and mixed lung function in the spinning workers of PT X Karanganyar. Overall the level of dust in the work environment at PT X is above the threshold value (NAV) of cotton dust of 0.2 mg / m³ based on the Republic of Indonesia Ministerial Regulation No. 5 of 2018. Suggestion: For further research, it is better to do the measurement using the Personal Dust Sampler, so the measurement results of dust are more specific, namely respirable/respirable dust (1-10 microns).

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