Lung Capacity Determinant Tirtonadi Bus Station Workers in Surakarta

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Abstract. Many factors affect the impaired lung function capacity. One of the dangerous pollutants in the air is the level of dust. Open the irritation of the upper respiratory tract. This study aims to look at the determinants of lung function capacity. The study was conducted at Tirtonadi Bus Station. This study uses an observational design with a cross-sectional design. The population of workers was 54 people after the inclusion and exclusion criteria from the total population. A sample of 50 workers was taken using a random sampling technique. Dust measurement based on SNI 16-7058-2004 uses a low volume sampler and is carried out at 06.00-10.00, 14.00-16.00. The measurement point is carried out at the west and east gates as the highest concentration of pollutants Measurement of lung function capacity using spirometry. Other variables were assessed using a questionnaire and a checklist sheet to determine the characteristics of the study respondents. The results showed significant levels of environmental dust, work area and use of substantial masks with impaired lung function capacity with p-values = 0.003, 0.005 and 0.001. The use of masks during work must be a must for workers to protect from dust exposure which generally comes from motorized vehicles.

1. Introduction
The development of technology in the land, sea or air transport sector makes it easier for someone to move from one place to another, in a short time. With the development of modern transportation equipment, the need for transportation facilities is directly proportional to the increase in the number of transportation. However, increasing exhaust emissions have an essential role in increasing air pollution, which endangers human health. Data from the World Health Organization (WHO) in 2018 announced 7 million people in the world who are accepted every year due to air pollution. In Southeast Asia, more than 2 million people die from air pollution. Bloomberg (2015) also reports that Indonesia ranks number 8 out of 15 countries with the highest levels of air pollution in the world, with mortality reaching 50 thousand people each year [1].

The proportion of workers exposed to risk in developing countries is quite high. ILO 2017 data shows that countries with large incomes also show job losses with significant value. The number of...
occupational diseases is 90 percent of fatal occupational diseases globally, so it can be done by Bus station Workers who are at risk of occupational diseases [2]. ILO shows, every year, there are more than 250 million accidents at work, and 160 million become sick because of hazards that exist in the workplace. What's more, around 1.2 million workers die due to accidents and occupational diseases. New materials for the production process are distributed annually in the workplace. Apparently, many of them cause lung disease. Indonesia is one of the developing countries that has many companies that produce dust as a result of the production process. Occupational lung disease (PPAK) is a group of occupational diseases which are the target of the disease is lung [3].

Lung disease caused by prolonged or single exposure, moreover acute or chronic respiratory illness can be caused by severe exposure to irritating substances or toxins [4]. Occupational diseases are caused by pathological responses from patients to their work environment [5]. There is a consensus about the physical adverse effects on the breathing and functioning of industrial workers [6,7]. Research conducted by Rashyid (2013) based on the chi-square test The results of the study of anti-lung with a significance value of p-value = 0.036 which means it has a significant relationship with the value of p <0.05. Whereas in other studies conducted by Sangadah (2011) based on Pearson trials, the results obtained a significance of p-value = 0.02 between the addition of dust with impaired lung function [8].

Braum (1999) describes most cities in developing countries where the rate of urbanization is growing rapidly, the air pollution has damaged the respiratory system, especially for older, younger, smokers and those affected by diseases caused by respiratory tract [9]. The pathogenesis of byssinosis is the release of protein molecules that are part of the body's immune response that is released during an allergic reaction (histamine) which causes a reaction on the first working day after a Sunday holiday. Exposure to cotton dust that continues to increase over the years irritates the upper respiratory tract of the bronchus. After exposure, the chronic obstructive pulmonary disease may happen. Means it can be interpreted the longer the working period, the more cotton dust that settles in the respiratory tract, the more severe the disease of byssinosis suffered [3]. Tirtonadi Bus Station is one of the places with a high emission load from the vehicle bus station that exits the bus station every day. Passenger activities, vehicle exhausts, bus repairs, and bus engines that are not turned off during reception at Tirtonadi Bus Station will produce particulate dust emissions.

2. Methodology

2.1. Design study
This study uses an analytic observational design. Based on research conducted on cross-sectional where the cause/effect variable and the cause/effect are related or collected at the same time and carried out at the same time.

2.2. Population, sample and sampling method
This research was conducted in August 2019 in the workforce. The workforce population was 54 workers. After sampling using a random sampling technique to obtain 50 respondents as a sample. The independent variable in this study was work environment dust exposure, while the dependent variable was obstructive, restrictive and mixed lung function disorders.

2.3. Data collection method
Measurements of work environment dust levels were carried out at 2 points in the east and west areas with two measurements each. The first measurement in the morning time range is at 08-10.00 for 30 minutes, and the second measurement is at the range of 14.00-16.00 for 30 minutes using High Volume Sampler (LVS) tools. Procedure for measuring environmental dust based on SNI 16-7058-2004 concerning the measurement of total dust.

Impaired lung function disorders are classified into three, namely obstructive, restrictive, and mixed based on% FVC and% FEV1 measured using a spirometer. A spirometer is a tool used to find out the percentage of Forced Vital Capacity (FVC) and Forced Expiratory Volume that is forced in the first
second (FEV1). Pulmonary function is normal if % FVC ≥ 80% and % FEV1 ≥ 70% and obstructive disorders if % FVC > 80% and % FEV1 < 70%, restrictive disorders if % FVC < 80% and % FEV1 ≥ 70%, mixed disorders if % FVC < 80% and % FEV1 < 70%.

2.4. Analysis of data
Data analysis uses univariate analysis to distribute the characteristics of respondents and bivariate analysis with the Spearman correlation test to determine the relationship between variables and to see the strength of the correlation of the independent variables with the dependent variable.

3. Results
Tirtonadi Bus Station is one of the places with a high burden of air pollution due to vehicle emissions that go in and out of the bus station every day. The activity of raising passengers down, vehicle mufflers, bus repairs, and bus engines that are not turned off during a rest at Tirtonadi Bus Station will produce dust. While doing their job, Tirtonadi Bus Station field workers are certainly exposed to pollutant emissions from motor vehicles, especially dust. Safe limits for working environment dust are 0.5 mg/m³.

Characteristics of respondents consisted of age, sex, BMI and smoking behaviour, table 1 describes the youngest age of the worker, 24 years and the oldest 55 years with an average age of 44 years. When viewed from the age category according to the Ministry of Health in 2009, most respondents who worked in Tirtonadi Bus Station were in the early elderly category, as shown in table 2.

Table 1. Tendency characteristics of Tirtonadi Bus Station workers.

| Variable   | Mean | Median | SD   | Min | Max |
|------------|------|--------|------|-----|-----|
| Age        | 44.02| 48.00  | 10.32| 24  | 55  |
| Gender     | Male |        |      |     |     |
| BMI        | Normal |      |      |     |     |

For Gender, all-male respondents were taken with the results of BMI measurements all in the normal category. Table 3 shows the smoking behaviour of respondents where the results of the table show that respondents who smoke more experience impaired lung function capacity. Table 4 contains the results of statistical tests between work environment dust with obstructive, restrictive and mixed pulmonary function impairment to get a p-value = 0.003 (p < 0.05) which means there is a significant relationship, and a value of r = 0.406 with a positive relationship direction (+). This shows the significance of work environment dust with obstructive pulmonary function disorders, restrictive and mixed with a moderate level of relationship. The direction of a positive relationship shows that the higher the level of dust in the work environment, the more risk workers are exposed to impaired lung function capacity.

Table 2. Cross-tabulation between age categories and lung function capacity disorders

| Age Category     | Normal | Restrictive | Obstructive | Mixed | N  |
|------------------|--------|-------------|-------------|-------|----|
| Adolescent       | 0      | 1           | 0           | 1     | 2  |
| Was Early        | 3      | 5           | 1           | 1     | 10 |
| Late Adulthood   | 5      | 2           | 1           | 2     | 10 |
| Early Elderly    | 9      | 11          | 1           | 7     | 28 |
| N                | 17     | 19          | 3           | 11    | 50 |

Table 3. Distribution of respondents based on smoking behaviour and lung disorders

| Smoking Behavior | Lung Function Capacity | N  |
|------------------|------------------------|----|


| | Normal | Restrictive | Obstructive | Mixed |
|---|---|---|---|---|
| Yes | 5 | 10 | 2 | 6 | 23 |
| No | 12 | 9 | 1 | 5 | 27 |
| N | 17 | 19 | 3 | 11 | 50 |

Table 4. Effect of dust content on lung function capacity disorders

| Variable Independent | Variable Dependent | r     | p-value |
|----------------------|---------------------|-------|---------|
| Dust Content         | Lung Function Capacity | 0.406 | 0.003   |

Table 5. Work area with Tirtonadi Bus Station workers’ with lung function capacity disorders

| Work Area | Lung Function Capacity | P-Value |
|-----------|------------------------|---------|
| Normal    | Restrictive | Obstructive | Mixed |
| East area | 4 | 11 | 1 | 9 | 0.005 |
| West area | 13 | 8 | 2 | 2 | |
| Total     | 17 | 19 | 3 | 11 | |

Table 6. The effect of mask use on lung capacity disorders

| Variable Mask Use | Lung Function Capacity | r     | P-Value |
|-------------------|------------------------|-------|---------|
| Normal            | Restrictive | Obstructive | Mixed |
| Yes               | 9 | 1 | 0 | 1 | |
| No                | 8 | 18 | 3 | 10 | 0.451 | 0.001 |
| Total             | 17 | 19 | 3 | 11 | |

Table 5 shows the significant differences in workers exposed to dust. Worker bus stations in the eastern area compare more to restrictive, obstructive and mixed lung functions compared to workers bus stations in the western regions. Statistical test results also showed that there were significant differences with the value of p = 0.005. For table 6, explaining the use of masks is also related to lung function.

Table 7. Variable of influential on lung function disorder

| Variable          | B            | Koefisien β | p     | R²     |
|-------------------|--------------|-------------|-------|--------|
| Mask Use          |              |             | 0.002 |        |
| Work Area         | 1,075        | 0.418       | 0.001 | 0.283  |
| Dust Content      |              |             | 0.005 |        |
| Age               |              |             | 0.433 |        |
| Smoking behaviour |              |             | 0.131 |        |

Table 6 about the use of masks while working with impaired pulmonary function, whereas many as 66% experience impaired pulmonary function both restrictive, obstructive and mixed. Of the total 66% of workers who experience lung dysfunction, 62% of workers do not use masks and 0.04% of workers who wear masks still experience lung function disorders. Table 7 about the variables that most influence the pulmonary dysfunction from the use of mask, work area, dust content, age, and smoking behaviour variables. The work area became the variable that most affected the pulmonary function impairment of the Tirtonadi Bus Station workers with p-value = 0.001 and R² = 0.283. R² values indicate that 28.3% of lung function disorders are affected by work areas, and 71.7% are influenced by other variables.
4. Discussion
Measurement of work environment dust in the east and west areas with each of the 2 points in the Tirtonadi Bus Station obtained an average of 0.7335 mg/m³ and 0.309 mg/m³. The measurement results above the NAV are 0.5 mg/m³ every eight working hours per day in the western area. Based on Permenaker RI No. 5 of 2018 concerning occupational safety and health work environment appendix 3 NAV Chemical Factor [10].

The mechanism of dust accumulation in the lungs starts with breathing in, air containing dust enters the lungs. Dust that is between 5-10 microns will be held by the upper respiratory tract, while those that are 3-5 microns will be retained by the middle part of the airway. Particles with a size between 1 and 3 microns will be placed directly on the surface of the lung alveoli. Particles with a size of 0.1 microns do not so easily land on the alveoli, because particles of this size do not settle to the surface easily. Dust with less than 0.1-micron particles having mass is too small, so it does not settle on the surface of the alveoli or the lining of the lender, because of Brown's motion, which causes such dust to move out of the alveoli [11].

Suma'mur (2014) also explains that continuous exposure to cotton dust for years causes irritation of the upper respiratory tract of the bronchus. After exposure continues to occur chronic obstructive pulmonary disease which can be interpreted the longer the working period, the more cotton dust that settles in the respiratory tract, so the more severe the disease suffered byssinosis [12].

Dust can cause lung damage and fibrosis if inhaled during continuous work. If the alveoli harden, consequently reducing elasticity in accommodating air volume so that the ability to bind oxygen decreases. These results are also in accordance with a study by Qian in 2015 that there is a relationship between dust exposure and lung function disorders [13].

Dust exposure can reduce lung function, in this study we get results that there is a significant relationship between dust exposure and reduced lung function, these results are consistent with research conducted by Mohammadein et al. and Said et al. showed that there was a significant relationship between workers exposed to dust with impaired lung function where workers exposed to dust have a higher risk than those not exposed to dust [14].

Guyton (2008) as a person ages the lung function will decrease. Age is related to the ageing process or increasing age where the older a person is, the greater the likelihood of lung function capacity. Guyton and Hall (2008) explained that at the age of 20-40 years is the maximum muscle strength in a person and will be reduced by 20% after the age of 40 years. The older a person is, the risk of impaired lung function is also high [15,16].

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. The Indonesian Ministry of Health (2003) explained that chronic disorders occur due to occupational dust exposure which is quite high and for an extended period of time which is usually annual and not infrequently the symptoms of lung function appear after more than ten years of exposure [11].

Guyton and Hall (2008), lung capacity can be influenced by a person's habit of running sports that someone who is regularly exercising can increase blood flow through the lungs which will cause pulmonary capillaries to get maximum perfusion so that oxygen can diffuse into the capillaries to the maximum [15].

Smoking may lead to clinically recognized chronic obstructive pulmonary disease (COPD) in 15–20% of those who smoke. COPD is characterised clinically by chronic respiratory symptoms such as cough and sputum production, airflow limitation (according to the European Respiratory Society (ERS), a forced expiratory volume in one second (FEV1)/vital capacity (VC) ratio of 88% of the predicted value in males or v89% pred in females) and an accelerated decline in FEV1 (w50 mL/yr). Smoking is the most crucial risk factor for developing COPD [17]. Research on the differences in lung function between smokers and non-smokers shows that there are significant differences, i.e. respondents who do not smoke and who already smoke have a lower risk of lung function than those who smoke [18,19].

Workers at the bus station have the same risk as workers who work on the highway. The risk of exposure to dust will cause lung function disorders. Several studies of occupational health risks in traffic
workers show that bus conductors and motorized vehicle drivers have a higher risk of 22.23. Tirtonadi Bus Station workers for eight working hours were exposed to motor vehicle fumes from the bus which contained dust, PM$_{10}$ and PM$_{2.5}$, and other toxic gases.

5. Conclusions

There is an influence between the level of work environment dust with pulmonary function disorders in Tirtonadi Bus Station workers with an average dust level of 0.7335 mg/m$^3$ that has exceeded the NAV according to Permenaker Number 5 of 2018. Suggestions for this study workers need to do a health examination and for the company provide N95 type masks as PPE for workers.

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