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Risk Factor Analysis and $PM_{2.5}$ Concentration on Community Lung Capacities Around the Konawe Industrial Area

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ABSTRACT

Introduction: Communities residing in industrial areas are the group most at risk of PM_{10} exposure. The Nickel Processing Industrial Area in Konawe Regency, Southeast Sulawesi Province is one of the largest in Indonesia. Communities living in the Industrial Area include Morosi District, Motui District, and Kapoiala District.

Method: The type of research used is quantitative research with a cross-sectional study design. The target population in this study is 2,420 people divided into 6 villages. The research sample was 343 people. Data analysis used the chi square test.

Result: The results of the analysis of the relationship to lung capacity obtained a history of respiratory disease with a p value (0.000) < 0.05, the presence of smokers at home with a p value (0.003) < 0.05, physical activity with a p value (0.008) < 0.05, and $PM_{2.5}$ concentration with p value (0.397) > 0.05.

Conclusion: There is a relationship between history of disease, presence of smokers in the house, and physical activity with the lung capacity of the community and there is no relationship $PM_{2.5}$ concentration with community lung capacityaround the Konawe Industrial Area.

Introduction

Air is one of the important factors in life, but with the increase in mining and mining product processing industries, air quality has changed. The air that was once clean, is now dry and dirty. If this is not immediately addressed, these changes can endanger public health, especially those within the scope of mining and industry.[1]

Emissions of air pollution by industry are very dependent on the type of industry and the process.[2] One of the industries that contributes to air pollution is the nickel smelter industry which is now thriving in Southeast Sulawesi Province. A large amount of dust is emitted at almost every stage of the nickel processing process, from extracting the main and auxiliary raw materials, to the raw and finished materials from the stockyard to the factory and then to the port. Nickel processing industrial dust consists of various sizes and shapes, and most of it consists of particulates with a diameter of less than 10 µm (PM_{10}) up to 2.5 µm ($PM_{2.5}$).[3]

Particulate matter (PM) or suspended dust particles are a very complex mixture of various organic and inorganic compounds such as sulfates, nitrates, ammonia, sodium chloride, carbon, mineral dust and water. These airborne particles in solid form have a diameter of less than 10 µm which is commonly referred to as PM_{10} and less than 2.5 µm namely $PM_{2.5}$ in the particle housing which triggers the emergence of respiratory tract infections, because solid particles PM_{10} and $PM_{2.5}$ can settle in bronchial passages and alveoli. Health impacts that can be found are Acute Respiratory Infections (ARI), including asthma, bronchitis, and impaired lung capacity as an indicator of respiratory problems.[4]

Communities residing in industrial areas are the group most at risk of PM_{10} exposure. The Nickel Processing Industrial Area in Konawe Regency, Southeast Sulawesi Province is one of the largest in Indonesia. Communities living in the Industrial Area include Morosi District, Motui District, and Kapoiala District.

Based on data from the Morosi Health Center, the prevalence of respiratory tract infections in the Work Area of the Morosi Health Center is one of the highest. It was recorded, from 2019 to 2021, the prevalence of respiratory tract infections ranged from 117 cases per 1,000 population to 126 cases per 1,000 population.[5] Based on this, the researcher intends to find out the relationship between $PM_{2.5}$ concentrations and the lung capacity of the people around the Industrial Area.

Method

The type of research used is quantitative research with a cross-sectional study design. This research was conducted in the area around the Konawe Industrial Area which consisted of 6 locations of concentration points for sampling, namely in Morosi District, namely Morosi Village, Puuruy Village, Lalembue Jaya Village, Tani Indah Village, Motui Village, and Tobimeita Village. The target population in this study is 2,420 people divided into 6 villages with a research sample of 343 people. Data collection was carried out using a questionnaire (question list), High Volume Air Sample (HVAS) as an aid in measuring $PM_{2.5}$ concentrations, Spirometer as an aid in assessing lung function. Furthermore, the data was tabulated and analyzed using the chi square test.

Result

Table 1 shows that as many as 54.0% of respondents have a history of respiratory disease and have normal lung capacity conditions, as many as 46.0% are not normal. And there are as many as 75.0% of respondents who have no history of respiratory disease have normal lung capacity conditions and as many as 25.0% are not normal. The test results obtained a P Value (0.000) <0.05, meaning that there is a relationship between a history of respiratory disease and lung capacity in the community around the Konawe Industrial Area.

Table 2 shows that as many as 32.6% of respondents who are smokers have normal lung capacity conditions, and as many as 67.4% are not normal. And there are also as many as 72.4% of respondents who are smokers in the house have normal lung capacity conditions and as many as 27.6% are not normal. The test results obtained a P Value (0.003) <0.05, meaning that there is a relationship between the presence of smokers in the house and the lung capacity of the people around the Konawe Industrial Area.

Table 3 shows that as many as 74.2% of respondents who do physical activity have normal lung capacity conditions, and as many as 26.9% are not normal. And there are also as many as 57.3% of respondents who do not do physical activity have normal lung capacity conditions and as many as 42.7% are not normal. The test results obtained a P Value (0.008) <0.05, meaning that there is a relationship between physical activity and lung capacity of the people around the Konawe Industrial Area.

Table 4 shows that as many as 74.2% of respondents aged> 40 years have normal lung capacity conditions, and as many as 25.8% are not normal. And there are also 64.8% of respondents aged <40 years who have normal lung capacity and as many as 35.2% are not normal. The test results obtained a P Value (0.397) > 0.05, meaning that there is no relationship between $PM_{2.5}$ air quality and lung capacity of the people around the Konawe Industrial Area.

Table 1.
Relationship between history of respiratory disease and lung capacity in the community around the Industrial Area of Konawe Regency

Disease History	Lung Capacity				Amount		P Value
	Normal		Abnormal				
	n	%	n	%	n	%	
There is	47	54.0	40	46.0	87	100.0	0.000
There isn't any	192	75.0	64	25.0	256	100.0	
Total	239	69.7	104	30.3	343	100.0	

Table 2.
The Relationship between the Presence of Smokers in the House and the Lung Capacity of Communities around the Industrial Area of Konawe Regency

Existence of Smokers	Lung Capacity				Amount		P Value
	Normal		Abnormal				
	n	%	n	%	n	%	
Yes	61	32.6	126	67.4	187	100.0	0.003
No	113	72.4	43	27.6	156	100.0	
Total	104	30.3	239	69.7	343	100.0	

Table 3.
Relationship between Physical Activity and Lung Capacity of Communities around the Industrial Area of Konawe Regency

Physical Activity	Lung Capacity				Amount		P Value
	Normal		Abnormal				
	n	%	n	%	n	%	
There is	132	74.2	72	26.9	268	100.0	0.008
No	43	57.3	32	42.7	75	100.0	
Total	239	69.7	104	30.3	343	100.0	

Table 4.
Relationship between $PM_{2.5}$ Concentration and Lung Capacity of Communities around the Industrial Area of Konawe Regency

$PM_{2.5}$ Concentration	Lung Capacity				Amount		P Value
	Normal		Abnormal				
	n	%	n	%	n	%	
Under Quality Standard	239	69.7	104	30.3	343	100.0	0.397
Total	239	69.7	104	30.3	343	100.0	

Discussion

Relationship of Disease History with Lung Capacity

Variable respiratory disease experienced by respondents, obtained as many as 25.4% of respondents who had respiratory diseases such as coughing, shortness of breath or cough accompanied by shortness of breath. The results of statistical tests using the chi square test showed that there was a relationship between the respondent's respiratory disease and lung capacity

(p = 0.000). In line with the research that has been done where there is a relationship between the history of the disease and the vital capacity of the lungs with a significance value of 0.024.[6]

Which found that the lung function of asthmatics was much slower than that of normal people with the same age and sex ratio. The FVC value for normal men aged 20-29 years is 102.69 ± 12.23 while for normal women of the same age it is 107.66 ± 15.07. Meanwhile, the FVC value for men with asthma in the same age range was 96.76 ± 17.22 and for women was 91.32 ± 23.12. Likewise, the FEVI value for normal men aged 20-29 years was 92.60 ± 14.15, while for normal women of the same age it was 106.72 ± 17.22. while the FEVI value in men with asthma in the same age range was 79.12 ± 27.19 and in women was 76.21 ± 27.19.[7]

The Relationship between the Presence of Smokers and Lung Capacity

The variable of the presence of family members who smoke in the house shows that 54.5% of respondents have family members who smoke in the house. The results of statistical tests using the chi square test showed that there was a relationship between the presence of smoking family members in the house and lung capacity (p = 0.002). The existence of family members who smoke in the house or known as passive smokers, what is meant is people who inhale the smoke exhaled by the smoker.

This study is in line with the results of research which obtained a relationship between smoking habits and lung vital capacity (p value = 0.0001 <0.05) and found that smoking can be a risk factor of 5.529 times the decrease in lung vital capacity compared to non-smokers.[8]The results of this study are in line with research which shows that there is a relationship between smoking habits and lung vital capacity with a p-value of 0.0001. According to Putra et al. Toxic substances contained in cigarettes will gradually accumulate in the body, especially in the lungs. The toxin will inhibit the process of gas exchange 0_2 with CO_2 in the alveoli, so that over time it can damage the alveoli. The number of functional alveoli that play a role in the respiration process will decrease which will then result in a decrease in the function of the lung organs and also a decrease in the vital capacity of the lungs.[9]

Physical Activity with Lung Capacity

The variable of sports activities or physical activity of respondents shows that there are as many as 81.3% of respondents who have a habit of doing sports or physical activities. The results of statistical tests using the chi square test also did not show that there was no relationship between sports or physical activity and lung capacity (p = 0.008). In line with research that found a strong positive relationship between physical activity and cardiopulmonary endurance (VO2 max).[10] In accordance with research that obtained a relationship between the level of physical activity and lung vital capacity supported by research data, which means that the better the level of physical activity, the better the value of lung vital capacity. By obtaining the coefficient of determination of the level of physical activity on the vital lung capacity (ry22) = 0.2332, this means that 23.32% of the vital lung capacity is determined by the level of physical activity.[11]

Research conducted by Azad et al. which reveals that exercise can by strengthening the muscles of breathing improve lung function. However, to achieve predictive values of lung function, exercise activity must be continued routinely and a decrease in BMI is required.[12]

Relationship between $PM_{2.5}$ Concentration and Lung Capacity

The results of the analysis of ambient air quality were obtained from the six measurement locations, all locations in the community settlements of Motui Village, Tobimeita Village, Lalembue Jaya Village, Tani Indah Village, Morosi Village and Puuruy Village had air quality below the quality standard. for the $PM_{2.5}$ parameter, the average measurement was 24 hours at a concentration of 2,075 µg/Nm³.

Based on the analysis of the relationship between $PM_{2.5}$ and lung capacity, it illustrates that the average measurement results are below the quality standard and also the results of statistical tests using the chi square test do not show a relationship between $PM_{2.5}$ air quality and lung capacity (p = 0.379). This is in line with research conducted on limestone workers where no relationship was found between lime dust levels and lung function status in limestone workers, because the concentration of dust in the work environment was still normal, below the predetermined NAV.[13] In addition, other studies

have found that the levelsdust has a significant relationship with the vital capacity of the respondent's lung. The OR value shows a result of 2.37 meaning that respondents who live in areas with dust levels that do not meet the requirements have a 2.37 times greater risk of having impaired lung vital capacity compared to respondents who live in areas with dust levels that meet the requirements.[14]

Conclusion

Based on the results of research conducted on "Risk Factors Analysis and $PM_{2.5}$ Concentrations on Community Lung Capacities Around the Konawe Industrial Area" obtained the following conclusions:

1. There is a relationship between a history of respiratory disease, the presence of smokers at home, and physical activity with the lung capacity of the people around the Konawe Industrial Area.
2. There is no relationship between $PM_{2.5}$ concentrations and the lung capacity of the people around the Konawe Industrial Area.

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