Analysis of factors related to lung dysfunction among coal mining workers in coal processing plant

Ratna Yuliawati,[1] Risma Arum Lintar,[1] Ainur Rachman,[1] Marjan Wahyuni[2]

[1]Department of Environmental Health, and [2]Department of Public Health, Universitas Muhammadiyah Kalimantan Timur, Indonesia

Abstract

East Kalimantan is one of the largest areas of the coal mining industry, which can cause many health problems, such as lung disorders. The purpose of this research was to identify factors associated with lung disorders among coal mining workers in the Coal Processing Plant at Kutai Kartanegara. This research was observational analytic with cross sectional design. Twenty respondents participated in this research (total sampling). Data was collected by questionnaire and lung function was assessed by the spirometer. Data was analyzed by chi-square test. The results showed that there was a correlation between smoking habits and lung function (p=0.02), the use of masks and lung function (p=0.038), duration of work and lung function (p=0.04), and dust inhaled with lung function (p=0.04). This study showed that there was no correlation between age and lung function (p=0.77) and exercise habits and lung function impairment (p=0.178). Based on research results, to maintain the health of coal mining worker, the factory should apply smoke prohibition, safety assessment for the worker, and manage time off work for the workers.

Introduction

Pulmonary function disorders are pulmonary disorders in the form of inability to develop (elasticity) of the lungs, both structural (anatomical) and functional, which causes a slowing of air flow respiration. Types of pulmonary function disorders can be Restriction, Obstruction and Mixture.[1]

Exposure to dust in the work environment can cause a variety of occupational lung diseases that produce pulmonary function disorders. Dust factors include particle size, the form of concentration, solubility and chemical properties are the causes of pulmonary function disorders. Besides, the next factors are individual factors including lung defense mechanism, airway anatomy and physiology and immunological factors. Assessment of exposure in humans needs to be considered, among others, sources of exposure/type of plant, length of exposure, exposure from other sources, physical activity and potential accompanying factors such as age, gender, ethnicity, smoking habits, allergen factors.[2,3]

Looking at epidemiological byssinosis, the prevalence is very high in jobs with high cotton dust. Pain rates can reach 70% of workers who breathe dust and 14% of employees who blow cotton dust are found to have lung defects. The prevalence of lung disease is very large, and it is estimated that more than 80,000 people in the United States die each year from chronic pulmonary disease. More than 5 million suffer from pulmonary function disorders, and more than 20 million have lung symptoms.[2]

Pulmonary disease from industrial dust has symptoms and signs that are similar to other lung diseases that are not caused by dust in the work environment. Diagnosis enforcement needs to be done a thorough history, including work history and other matters related to workers because new diseases arise after long exposure.[3-5] Some researchers have reported the effects of cotton/textile dust on pulmonary function disorders. The measurement of forced expiratory volume during the first second (FEV1) in workers exposed to cotton/textile dust shows signs of pulmonary obstruction. Exposure to the dust irritates the respiratory tract; this irritation subsequently results in pulmonary fibrosis so that eventually, lung dysfunction occurs. Lung restriction disorder is characterized by a stiffening of the lungs, stronger inward attraction so that the chest wall shrinks, the ribs narrows and lung volume shrinks. Obstruction is characterized by a problem in the airways that causes a slowdown in the air flow of respiration.

Various studies conducted related to pulmonary function, and it was reported that in sand mining and stone breakdown pulmonary abnormalities can occur after exposure to 1-3 years, in the ceramics industry clinical symptoms generally occur after five years in the rice milling industry lung disorders generally occur after 5 years of exposure,[6] in wood processing industries, pulmonary disorders occur typically after 5-6 years of exposure.[7]

Research on the decline in pulmonary function was also reported by Rajsri et al (2013) in India where there was a decrease in lung function in female weavers who worked a minimum of 5 years in which lung function parameters such as FVC, FEV1, FEV1 / FVC, and FEF 25% - 75% significantly reduced in weavers.[8] This research will analyze pulmonary function disorders in coal mining workers, the most potent part of which is in contact with coal dust, namely in the Coal Processing Plant (CPP).

Correspondence: Ratna Yuliawati, Department of Environmental Health, Faculty of Health Sciences and Pharmacy, Universitas Muhammadiyah Kalimantan Timur, Jl. Ir. H. Juanda No 15 Samarinda Kalimantan Timur 75243, Indonesia.
Tel.: +62.541.748511 - Fax: +62.541.766832
E-mail: ry190@umkt.ac.id.

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Materials and Methods

This study was an observational analytic study, with cross-sectional study design. The sample was chosen by the total sampling method. Dust levels were taken by using Personal Dust Sampler (PDS) lung volume measured using spirometry.

Questionnaires were used to collect data on age, years of service, body mass index, mask use, smoking habits. Data analysis was carried out with univariate, bivariate and multivariate analyses. The univariate variable analysis is categorized and described by making distribution and frequency, and the results are presented in Table 1.

Results and Discussion

Bivariate analysis

The results of the bivariate analysis recapitulation, as shown in Table 2 shows the variable dust levels associated with lung function disorders. The discussion of bivariate analysis is as follows.

The results of multivariate analysis showed that the risk of workers exposed to dust particles > 0.2 mg/m3 had a prevalence ratio of 27.203 with (95% CI = 1.885-39.257) (Table 3).

Total levels of smoked particles

The total level of sucked particles is an essential parameter for assessing the possible negative effects on the lung function of the coal miner. Sucked dust levels that exceed 0.2 mg/m3 are threshold values for unclassified dust in the mining industry. The results of multivariate analysis showed that the risk of workers exposed to dust particles > 0.2 mg/m^3 had a prevalence ratio of 9.833. This means that coal miners who are exposed to sucked particles > 0.2 mg/m^3 per day have a nine times greater risk of experiencing lung disorders. Dust that is inhaled during breathing with a specific concentration will endanger human health, can be accompanied by complaints of coughing, sneezing and shortness of breath. Exposure to dust for a certain period will cause complaints to workers, but it is influenced by the durability of the workforce.[3]

Coal particles of more of 5 µm up to 15 µm who settle on a tract of the breath will irritate bronchitis gain full recovery of the compulsory or recover. While particles that are sized 0.5 µm to 5 µm will enter alveolus and is generally will be cleaned and removed them again by the bronchi and trachea macrophages, but exposure to high will result in resistance and intensity of such particles in lung disorder. Generally rarely coal mine workers of experiencing the failure of pulmonary function meaningful because coal dust is dust that have the potential to low fibrogenic.[7]

Working period

The results of the analysis showed that the working period was associated with the occurrence of lung function disorder impairment in coal mining workers, with a prevalence ratio of 21.502 at 95% CI = 9.559-483.655 Workers who have a working period of > 10 years have 21 times the risk of experiencing lung function disorders. From some of the previous studies, all of them supported the findings of this study, although the length of exposure that resulted from each study was different. This is likely to be influenced by different types of materials of exposure and the presence of other variables that can affect the occurrence of pulmonary function disorders. Working period is related to the duration of labour contact with coal dust, the longer contact with dust will affect lung abnormalities can be in the form of restrictions, obstruction or a mixture of both. The obstacle is a nonspecific disorder of exposure to coal dust but can also occur due to exposure to the length of contact with dusts.[6]

Use of masks

The results of multivariate analysis showed that workers who did not use masks have an increased risk for pulmonary function disorders. The prevalence value ratio of 40.965 95% CI is 2.831-68.280. This means that workers who did not use masks are at risk for lung function impairment 44 times greater than workers who use masks.

Workers whose work activities are heavily exposed to dust particles need personal protective devices in the form of a mask to reduce the number of particles that are likely to be inhaled. However, it turns out that not all workers who use masks in this study can avoid the risk of pulmonary function disorders. The results showed that 12.5% of workers who used masks also experienced pulmonary function disorders. This is likely due to the quality of the mask used is less standardized.

The use of personal protective equipment in the form of masks has the purpose of preventing the exposure of coal dust so that it can minimize contact with coal miners as much as possible. Three types of respiratory protective devices can be used, including water purifying respirators, respirators, self-contained breathing devices. Factors that influence the effectiveness of personal protective equipment are the compatibility between the type of particle with the tool, the method of use and the feasibil-

Table 1. Description of the frequency of worker variables.

Variable	Mean	Median	SD	Min.	Max.
Age (year)	30.7	34	2.57	12	40
Working Period (year)	7.7	12	2.24	1	16
Dust sucked (mg/m^3)	0.9	0.7	0.82	0.1	4.4
Body mass index	21.4	20.2	3.26	16.9	26.3
% FEV/FVC	77.9	78.4	12.4	40.0	129.4

Table 2. The Relationship between The Total Levels of Particles Sucked and Pulmonary Function Disorders.

Total smoked particles	Lung function disorders		P value	PR 95%CI
	Disturbed	Not disturbed		
>0.2 mg/m^3	0 (0%)	4 (4%)	0.04	9.833 (2.154-44.895)
≤0.2 mg/m^3	9 (33.3%)	7 (66.7%)		

Table 3. Multivariate analysis results.

No.	Free variable	B	Sig	Exp(B)	95% CI	
					Lower	Upper
1	Total levels of sucked particles (> 0.2 mg/m^3)	3.303	0.04	27.203	1.885	39.257
2	Working period (≥ 10 tahun)	5.371	0.001	21.502	9.559	48.365
3	Use of masks (sometimes)	3.783	0.038	43.965	2.831	68.280
4	Smoking habit	3.317	0.02	27.583	1.955	38.925
	Constant	-9.751	0.001			

ity of the protective devices. The company also expected to monitor its compliance among labour who used masks during work hours because the research results showed that coal workers were still being indicated to suffer from lungs disorder though they used masks.[8]

Age

In this study, age is another factor that might cause lung diseases. Age is a natural factor that can reduce lung function capacity. The respiratory system will change anatomically and immunologically according to age. Human lung capacity will reach its optimum level until age of 24 years old. Then, its function will decrease in value of FVC and FEV1 about 20 ml.[9] The results of multivariate analysis showed that this variable was not considered to contribute to the occurrence of pulmonary function disorders in the mattress making workers.

There are other variables that directly affect the occurrence of pulmonary function disorders, namely dust sucked. Furthermore, the dose of inhaled dust can result in impaired pulmonary function after recurrence of pulmonary function disorders.

Nutritional status

The failure to pass the nutritional status variable into the multivariate model in this study is likely due to workers who had poor nutrition. Low nutritional status will also affect immune system, as well as obesity that will affect lung function capacity. In the case of obesity, there will be a buildup of adipose tissue on the chest wall and abdominal cavity that suppresses the chest cavity, abdominal cavity and lung due to decreased compliant power so that it will also reduce the value of FEV1 and decreased lung air capacity.[6]

Smoking habit

The results showed that smoking habits are a risk factor for lung function disorders. Cigarette smoke is a pollutant that is harmful to the lungs because cigarette smoke inhaled by a smoker is higher than the air pollutants in the atmosphere. Pulmonary disorders that occur in labour are influenced by the number of cigarettes for one day and can also be affected by individual vulnerability and how to smoke cigarettes. Smoking can cause mucosal hypertrophy and increase mucous secretion so that it can lead to the obstruction, which is characterized by a decrease in % FEV1. Therefore, the action that can be recommended for coal mining workers in the coal processing plant is to able to stop smoking.[10,11]

The effect of toxicology exposure to dust in work environment could make synergy with the impact of exposure to cigarette; however workers who work in the vicinity of the dusty and smokers will more susceptible to lungs disorder than workers in the same neighborhood but not smokers.[12,13]

Multivariate analysis

Based on the results of the bivariate test, it is known that five variables can be analyzed by multivariate analysis using logistic regression. The results of multivariate analysis showed that the risk of workers exposed to dust particles > 0.2 mg/m^3 had a prevalence ratio of 27.203 with (95% CI = 1.885-39.257). This means that coal miners in the Coal Processing Plant section exposed to sucked particles > 0.2 mg/m^3 per day have a 27 times greater risk of experiencing pulmonary function impairment.

The results showed that the work period was related to pulmonary function impairment in workers, with a prevalence ratio of 21,502 at 95% CI=9.559-48.365 This means that the working period is a risk factor for pulmonary function impairment.

Conclusions

It can be concluded that there was a significant relationship between levels of particulates sucked, working period, the use of PPE, smoking habits and pulmonary function disorders in coal mining workers. There was no significant relationship between age and pulmonary function disorders in coal mining workers.

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