

## Original Research

**RESPIRABLE DUST LEVELS, YEARS OF SERVICE, AND PULMONARY PHYSIOLOGICAL DISORDERS IN MARBLE HOME INDUSTRY WORKERS**Siti Arum Alia,<sup>1</sup> Noeroel Widajati,<sup>1,2</sup> Tri Martiana,<sup>1</sup> Firda Qurba Sari,<sup>1</sup> Abdul Rohim Tualeka<sup>1</sup><sup>1</sup>Department of Occupational Safety and Health, Faculty of Public Health, Universitas Airlangga, Surabaya, Indonesia<sup>2</sup>Master of Occupational Health Science Study Program, Faculty of Medicine, Universitas Gadjah Mada, Indonesia**ABSTRACT**

*Environmental dust in the workplace exposes the workers as they are breathing. The dust is inhaled into the respiratory tract and causes occupational diseases in the form of pulmonary function disorders. Workers in the marble industry are also prone to dust exposure. This study aimed to analyze the correlation between years of service, respiratory dust levels, and pulmonary function disorders in marble home industry workers in Tulungagung Regency, Indonesia. This study was a descriptive observational study with data from a cross-sectional technique. The population was 18 workers taken as respondents. The independent variables in this study were years of service and the level of respirable dust, while the dependent variable was the pulmonary function disorders experienced by the workers. The data were analyzed using the Correlation Contingency test. There was a close correlation between years of service and pulmonary function disorders by 0.196, indicating that the relationship between those variables was weak. The strength of the relationship between respiratory dust levels and pulmonary function disorders could not be obtained because the constant results met the threshold value. The correlation between years of service and pulmonary function disorders was weak, and the relationship between respiratory dust level and pulmonary function disorders could not be obtained.*

**Keywords:** Dust exposure; pulmonary disorder; occupational disease; good health and well-being

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**Hi j n i j t u r**

1. The strength of the relationship between respiratory dust levels and pulmonary function disorders could not be obtained.
2. The weakness level of correlation between years of service and pulmonary function disorders.

**INTRODUCTION**

Based on the data from the International Labor Organization (ILO) in 2012, occupational accidents and diseases caused 2 million cases of mortality every year. The Ministry of Health of the Republic of Indonesia has noted that in 2013, every 15 seconds, one worker in the world died from a work accident, while 160 experienced work-related illness. According to data from the World Health Organization (WHO) in 2007, among all cases of occupational diseases, 30' /50' of them are pneumoconiosis. In addition, the ILO detected 40,000 new cases of pneumoconiosis or respiratory diseases every year around the world due to exposure to dust in the workplace (Abidin et al. 2015).

When humans breathe, the dust in the environment is inhaled and enters the respiratory tract. The dust will reach different target organs based on the concentration and size of the dust. Dust particles with a size of 1 micron will undergo diffusion or brown movement and settle in the alveoli. Dust particles of 1-5 microns will settle (sedimentation) in the middle respiratory tract, such as bronchiole and bronchi. Meanwhile, dust with a size of 5-10 microns will easily stick to the mucosa of the upper respiratory tract (*inertia impaction*), and rarely enter the bronchi and smaller channels. Dust particles are dangerous when they are 0.1-10 microns (Suma'mur 2009).

According to the Minister of Manpower Regulation No. 5 of 2018 concerning Occupational Safety and Health in the Work Environment, the substance of respirable particulate dust in the work environment is 3 mg/m<sup>3</sup>. Dust levels that exceed the threshold can cause interference with lung function. Lung function disorders can occur due to exposure to dust particulates (Andersson et al. 2020, Habybabady et al. 2018), especially in obstruction or restriction, or it could be both. A person has obstructive pulmonary function disorders if the value of the forced expiratory volume in the first second (FEV1) is less than 75%, and restrictive pulmonary function disorders if the value of vital capacity (Vital Capacity/VC) is less than 80% compared to the standard value (Alsagaff et al. 2020). Several factors can affect a person's health due to dust, including dust levels in the air (Dwicahyo et al. 2019), dust properties (Cui et al. 2021), and dust size or diameter (Khan & Strand 2018, Manisalidis et al. 2020). The other common factors are dust reactivity, working weather, length of time of exposure, and individual sensitivity (Siswanto 1991).

One of the industries with the potential for exposure to dust in the workplace is the marble industry. This industry produces marble dust which contains several chemicals, such as SiO<sub>2</sub>, MgO, and CaO. The marble dust also contains PM<sub>2.5</sub> and PM<sub>10</sub> in its chemical composition (Iqbal et al. 2022). One of the developing marble industries is located in Tulungagung Regency, Indonesia. The processing of marble stones in the home industry consists of cutting, refining, drying, caulking, heating, and polishing. Some processes that result in dust exposure include the cutting, grinding, and polishing processes because the entire production process still uses human labor, and workers risk being exposed to dust in the workplace.

The dust accumulated over a long period can cause pulmonary function disorders in workers (Oo et al. 2021). The longer the working period, the longer the period the worker is exposed to dust. This study analyzed the relationship between years of service and levels of respiratory dust and pulmonary function disorders in marble home industry workers in Tulungagung Regency, Indonesia.

## MATERIALS AND METHODS

This study was descriptive-observational research with a cross-sectional technique. This research was conducted in the marble home industry in June 2019, located in the Tulungagung Regency, Indonesia. The respondents in this study were 18 workers with inclusion criteria of willingness to participate in the study, had no history of respiratory disease, were not suffering from respiratory disease, and were working when this study was taking place.

The independent variables were years of service and the level of respirable dust in the workplace, while the dependent variable was pulmonary function disorders. The data were mainly obtained through a questionnaire distributed to the respondents. The working period variable was obtained through direct questionnaires to workers. Variable levels of respirable dust were obtained through measurements using a Personal Dust Sampler conducted by officers of the East Java UPT K2 of Manpower and Transmigration Office. Pulmonary function disorder variables were obtained through measurements using a spirometer conducted by officers of the UPT K2 of Manpower and Transmigration Office, East Java, Indonesia.

Data analysis was carried out using univariate and bivariate analysis. Univariate analysis was carried out by presenting data in tabular form and percentage of data, while bivariate analysis was used to see whether or not there was a relationship between variables using the Correlation Contingency test.

## RESULTS

In processing marble stone from mining, a work process cannot be avoided from exposure to dust. The processing of marble stone goes through several stages in the form of cutting, polishing, scrubbing, lathe, craft operator, finishing, and packing. The distribution of workers was based on years of service and the results of measurements of respirable dust levels.

The number of workers with a working period of  $\geq 5$  was higher (83.33%) compared to that who had  $< 5$  years of service (16.67%). Based on data on respirable dust levels, the highest level was in the cutting section work unit by 1.5524 mg/m<sup>3</sup> (4 workers), while the work unit with the lowest respirable dust level was the packing unit (1 worker) with a value of 0.444 mg/m<sup>3</sup>.

Table 1. Distribution of respondents based on years of service and respirable dust levels

Variable	Total	Percentage
Years of service		
$\geq 5$ years	15	83.33
$< 5$ years	3	16.67
Total	18	100
Respirable dust level		
0.4444 mg/m <sup>3</sup> (Packing)	1	5.56
0.4447 mg/m <sup>3</sup> (Finishing)	2	11.11
0.8865 mg/m <sup>3</sup> (Scrub and Polish)	7	38.89
0.8877 mg/m <sup>3</sup> (Lathe)	3	16.67
1.0867 mg/m <sup>3</sup> (Craft Operators)	1	5.56
1.5524 mg/m <sup>3</sup> (Cutting)	4	22.22
Total	18	100

In other units, the respirable dust level of 1,0867 mg/m<sup>3</sup> was found in the craft operator work unit (1 worker), 0.447 mg/m<sup>3</sup> in the finishing work unit (2 workers), and 0.8865 mg/m<sup>3</sup> in the scrub work unit, and polish unit (7 workers). The measurement results of respirable dust levels in the workplace did not exceed TLV based on the Minister of Manpower Regulation No. 5 of 2018 (3 mg/m<sup>3</sup>). Furthermore, three workers (16.67%) experienced pulmonary function disorders or abnormal lung status, while 15 workers (83.33%) had normal lung conditions. Workers with pulmonary function disorders were identified in the restrictive category and had the lowest% FEV value of 41.8.

Table 2. Measurement results of lung physiological disorders

Pulmonary Physiology status	Total	Percentage
Normal	15	83.33
Abnormal	3	16.67
Total	18	100

Pulmonary function disorders experienced by workers with a work period of  $\geq 5$  years were higher than those with a work period of  $< 5$  years. Of the 15 workers with a work period of  $\geq 5$  years (20%), they experienced pulmonary physiological disorders, while the other 12 workers did not experience pulmonary function disorders. The relationship and Correlation Contingency test results showed a correlation value of 0.196, indicating that the level of the relationship between the two was weak.

Based on the dust measurement, there were 3 workers (16.67%) with pulmonary function (restriction) disorders and respirable dust levels under the Threshold Limit Value ( $< 3$  mg/m<sup>3</sup>) specified in the Regulation of the Ministry of Manpower and Transmigration Number 5 of 2018. A total of 15 other workers with respirable dust levels met the requirements and did not experience pulmonary function disorders.

## DISCUSSION

Abnormal pulmonary function conditions or pulmonary function disorders were only found in workers with  $\geq 5$  years work period. This finding was consistent with Sudrajad's (2016) research that workers with  $> 5$  years of service had a greater risk of experiencing lung function disorders because inhaled dust particles have settled in the alveoli.

Workers working in environments with high particle levels for long periods were at high risk of developing pulmonary obstruction disorders (Grahm et al. 2021, Liu et al. 2017). The value of the Correlation Contingency test results was 0.196, indicating that the relationship between the years of service and pulmonary function disorders was weak. A study indicated no significant relationship between the years of service and pulmonary function disorders (Taruna 2015).

The relationship between the years of service and pulmonary function disorders was found weak because the length of service does not always determine whether the workers experience pulmonary function disorders. The results of the Correlation Contingency showed a positive value, indicating that the longer the years of service, the higher the risk of workers suffering from pulmonary function disorders, even though the relationship was weak.

A comparison of the measurement results of respirable dust exposure in Tulungagung marble home industry and the Regulation of the Minister of Manpower Number 5 of 2018 concerning Occupational Safety and Health at Work Environment, showed that all work units had met the specified threshold value for respirable dust of 3 mg/m<sup>3</sup>. However, based on the results of pulmonary function measurements, some workers experienced pulmonary function disorders, even though the dust levels were below the threshold. This indicated that the respirable dust below the

Table 3. Results of correlation contingency analysis

Variable	Pulmonary physiological (restriction) disorders				Total		Contingency coefficient
	Normal		Abnormal		n	%	
	n	%	n	%			
Years of service							
$\geq 5$ years	12	80	3	20	15	100	0.196
$< 5$ years	3	100	0	0	3	100	
Respirable dust content							
Above threshold limit value (TLV) ( $> 3$ mg/m <sup>3</sup> )	0	0	0	0	0	100	0.514
Under threshold limit value (TLV) ( $\leq 3$ mg/m <sup>3</sup> )	15	83.33	3	16.67	18	100	

This indicated that the respirable dust below the threshold value still presents a high risk for workers to experience pulmonary function disorders. Although the results showed that exposure to respirable dust was below the threshold value, this fact had to be a concern because the respirable dust inhaled daily could be deposited in the lungs. Similarly, a study also found that the pulmonary function disorders occurred higher in respondents whose workplaces had exposure to respirable dust below the threshold value (Sari 2018).

### Strength and limitation

The study focuses on an important topic related to occupational health and safety, specifically the impact of dust exposure on respiratory function in marble industry workers. The sample size is small, with only 18 workers taken as respondents in marble industry in Tulungagung Regency, Indonesia, which may limit the generalizability of the findings and may not be representative of other industries or locations.

### CONCLUSION

The relationship between years of service and pulmonary function disorders was weak, while the relationship between respiratory dust levels and pulmonary function disorders could not be obtained because the results of measurements of respirable dust levels were constant and met the threshold value. In addition, workers should always use personal protective equipment of masks suitable for the workplace conditions and use them in any work unit location. Workers are also advised to maintain physical health with adequate rest, nutritious foods, and regular exercise.

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### Conflict of interest

None

### Funding disclosure

None

### Author contribution

SAA, NW, and TM conceptual, study design, analysis data. FQS, and ART write and revised the manuscript. NW validation of all manuscript data.

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