

## MARBLE DUST EXPOSURE RELATIONSHIP TO WORKERS' LUNG CONDITIONS IN MARBLE INDUSTRIES

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### Abstract

**Introduction:** Marbel mining in Tulungagung caused air quality pollution of dust. The level of air pollution in the marble industrial mining area in Besole village, Tulungagung, was a high category. Air pollutions from dust cause fibrosis in the lungs if continuously inhaled. This marble dust belongs to the group of differentiative dust—pulmonary disorders due to dust in the form of restriction, obstruction, or mixture of the two. The study aims to analyze the internal factors related to lung conditions in one of the Besole Village industries, Tulungagung. **Method:** research that has been done using cross-sectional design through a quantitative approach. Determination of the sample size by simple random sampling. Twenty-four workers consisting of 12 exposed and 12 were not exposed to dust. **Result and Discussion:** The results of measurements of marble dust levels in the study area were 20,000 mg/m<sup>3</sup>, which exceeds the specified threshold value. Meanwhile, the statistical test value  $p = 0.000$  means a relationship between dust levels and the condition of workers' lungs in the exposed area. Most workers' lung conditions in one of the Besole village industries are quite good. **Conclusion:** The condition of the lungs is closely related to dust levels that exceed the threshold value. The lungs' condition is also influenced by work time and poor behavior; namely the habit of not wearing PPE and smoking habits, causing decreased lung function.

## INTRODUCTION

Polluted environmental conditions will affect the condition of public health status (1). The quality of polluted air is dangerous to health, namely dust that exceeds the threshold value during respiration (2). High dust levels cause acute respiratory infections, lung cancer, asthma, and impaired lung function (3-4). The level of dust that can enter the lungs is particulate because it can penetrate the inside of the lungs. Between 15% and 20% of common chronic obstructive pulmonary disease cases have been associated with occupational exposure to vapors, gases, dust, and fumes over a long time (5-8).

The level of particulate matter (PM<sub>2.5</sub>) that enters the alveoli causes inflammation and reduces lung function as indicated by decreased% FEV1 and% FVC parameters (9-10). Through the examination of lung function conditions in normal or abnormal conditions (11-12). The maximum particulate measurement (10 mg / m<sup>3</sup>) for 8 hours. The dust particulates are also divided into two, namely PM<sub>10</sub> and PM<sub>2.5</sub>. In previous studies, the minimum working period was one year due to at least one year of exposure to dust deposits in the lungs (13). In the previous case, sandstone workers in Thailand in the stone cutting and rock carving groups had been exposed to dust that exceeded the OSHA PEL threshold value (0.05 mg / m<sup>3</sup>) (14). A study conducted on 1,681 case groups and 2,053 control groups showed that exposed workers had a higher risk of experiencing health problems than those who were not. A similar condition to stone crusher workers in Buleleng Bali, showing that most of the workers were exposed to FVC values (58.3%) with a degree of restriction abnormality (54.17%) and mixed abnormalities 41.7%. Sandblasting worker with FVC parameter (b = 0.786 p = 0.001). For the FEV1 parameter (b = 0.144 p = 0.874) had less influence.

The World Health Organization (WHO) states that respiratory diseases from acute to chronic levels affect around 500 million people, especially in developing countries. According to WHO, in 2007, all diseases caused by work reached 30% to 50% were pneumoconiosis. The results of the ILO (International Labor Organization) detection of about 40,000 cases of pneumoconiosis caused by dust exposure. The dust concentration in mine workers in Kadijajo, Kenya, showed a significant correlation with distance, r = -0.41227, and p-value 0.0103. Comparison of dust concentrations for SiO<sub>2</sub>, Cr, and Pb in limestone, phonolite, and pozzolana showed p < 0.0001, p = 0.2071, and p = 1.460. The study showed that (60.55%) workers showed cough, 10% experienced skin irritation, and 2, 75%) experienced eye irritation. This study revealed that mineworkers' awareness of safety and health risks was 94.5%, but

only 16.51% used protective clothing (15).

Mining activities have the risk of destroying nature and causing groundwater to escape so that there is much sedimentation, which causes the natural balance to be disturbed (16). Marble mining industry centers affect environmental conditions. Previous research stated that there was a dust content with silica mineral content (64.18-92.68%), CaO (0.002% -0.005%), Al<sub>2</sub>O<sub>3</sub> (11.65-25.04%) and sludge content (15%) (17). The dust composition of marble dust is similar when compared to limestone. The effect of continuous dust exposure affects poor lung conditions (13,18).

Tulungagung is a small area rich in mining products, especially marble rocks from the transition of crystalline stones, which have experienced an increase in temperature and pressure. The marble characteristics are different from limestone or limestone, most of which have the same structure and are white (19). The impact felt by the community in Besole Village, especially around the marble mining area, is the polluted environment due to the mining process, residual dust from the marble crushing process, not to mention the subsequent stages and processes that cause air pollution such as lifting and transportation. In mining marble using heavy equipment, which can cause the collapse of the marble hill, the lands around the marble often occur landslides (19-20). This research was conducted in one of the marble industries in Besole Village, a larger processing industry than other industries, to observe dust levels and internal factors related to workers' lung conditions.

## METHOD

The research was conducted using a cross-sectional research design, supporting data obtained through observation, interviews, and measurement of dust levels using EPAM 5000 and spirometric measurements for lung function tests. The research was conducted from November 2019 to June 2020. The population of the research was 48 workers with the determination of the sample size using the stratified random sampling method so that a sample of 12 study groups and 12 control groups was obtained with a total of 24 workers with criteria of willingness to become respondents and tenure (minimum one year). The statistical analysis used the chi-square test to determine the relationship between the variables analyzed, including age, years of service, nutritional status, PPE, smoking habits, and exercise. Informed Consent followed from previous research and had passed the validation test. This research received approval from the National Ethics Commission of Health, Faculty of Dentistry, Universitas Airlangga with ethical certificate number: 024 / HRECC.FODM / 1/2020

**RESULT**

**Measuring the Physical Quality of the Environment**

Table 1 showed that environmental quality in one of the marble industries in Besole Tulungagung Village consists of groups exposed and not exposed to measurements of temperature, humidity, and dust content. In the control group area of 0.041 mg/m<sup>3</sup> and the study group area of 6.615 mg/m<sup>3</sup>. The maximum PM<sub>2.5</sub> dust exposure was in the study group area of 20,000 mg/m<sup>3</sup>.

**Table 1. Measurement EPAM 5000 in the Heart of One of the Marble Industry of the Village Besole, Tulungagung**

Description	Group Studies	Group Control
Maximum	22,000 mg/m <sup>3</sup>	0.081 mg/m <sup>3</sup>
Minimum	0.171 mg/m <sup>3</sup>	0.000 mg/m <sup>3</sup>
The average	6,615 mg/m <sup>3</sup>	0.041 mg/m <sup>3</sup>

**Worker Characteristics**

The characteristics of workers showed in Table 2, include age, years of work, nutritional status, use of PPE, smoking habits, and exercise, mostly done in the age range of 46-55 years; that is, there are ten people (41.7%). The dominant working period ranges from 13-19 years, namely, ten people (41.7%). The nutritional status of most workers in the normal category was 16 people (66.7%). The majority of marble workers did not wear PPE while working as many as 18 people (75%), and the majority of workers also had a smoking habit of 16 people (66.7%). Exercise habit behavior before or after work is rarely done. In the table, only eight people (33.3%) did sports, and 16 people (66.7%) never did sports as dominant. The distribution of the study group and the control group is equal and evenly distributed.

**Table 2. Distribution Frequency among the Characteristics of the Workers of the Marble against the Status Faal Lung in the Village Besole**

Variable	Group Studies		Group Control		Total	
	n	%	n	%	n	%
<b>Age</b>						
26 – 35 years	2	16.7	2	16.7	4	16.7
36 – 45 years	3	25.0	3	25.0	6	25.0
46 – 55 years	5	41.7	5	41.7	10	41.7
56 – 65 year	2	16.7	2	16.7	4	16.7
<b>The work</b>						
< 5 years	2	16.7	2	16.7	4	16.7
6-12 year	4	33.3	4	33.3	8	33.3
13-19 year	5	41.7	5	41.7	10	41.7
>20 year	1	8.3	1	8.3	2	8.3
<b>Nutrition Status</b>						
Skinny	2	16.7	2	16.7	4	16.7
Normal	8	66.7	8	66.7	16	66.7
Overweight	2	16.7	2	16.7	4	16.7
<b>PPE</b>						
Wear	6	50	0	0	6	25
Do not wear	6	50	12	100	18	75

Variable	Group Studies		Group Control		Total	
	n	%	n	%	n	%
<b>Smoking</b>						
Yes	8	66.7	8	66.7	16	66.7
Not	4	33.3	4	33.3	8	33.3
<b>Sports</b>						
Yes	4	33.3	4	33.3	8	33.3
Not	8	66.7	8	66.7	16	66.7

**Pulmonary Function Status Condition of a Marble Company in Besole Village, Tulungagung**

The measurement of lung function for marble workers in Besole Village used a spirometer showed in Table 3. It was found that the control group had normal pulmonary function status as many as 12 people (100%), while for the study group, there were two people (16.7%) who had normal lung function, the majority experienced mild restriction, there were nine people (75%) and one person experienced moderate, severe restriction (8.3%). The total number of people with normal pulmonary function status was 14 people (58.3%). Workers exposed to normal pulmonary function status were two people (14.3%) and ten people who experienced restrictions (100%). 12 workers were not exposed to normal lung function conditions (85.7%), and none experienced lung restriction.

**Table 3. Ties Levels of Marble Dust and the Characteristics of the Workers of the Marble Against the Status Pulmonary Besole Village, Tulungagung**

Variables	Restriction		Normal		Total		p-value
	n	%	n	%	n	%	
<b>Levels dust</b>							
≤ Ten mg/m <sup>3</sup>	0	0	12	100	12	100	0.000*
≥ Ten mg/m <sup>3</sup>	10	83.8	2	0	12	100	
Total	10	41.7	14	53.3	24	100	
<b>Age</b>							
≤ Forty five year	2	20	8	80	10	100	0.104
≥ Forty six year	8	57.1	6	42.9	14	100	
Total	10	41.7	14	58.3	24	100	
<b>The work</b>							
≤ Ten year	2	16.7	10	83.3	12	100	0.013*
≥ Eleven year	8	66.7	4	33.3	12	100	
Total	10	41.7	14	58.3	24	100	
<b>BMI</b>							
Normal	5	31.3	11	68.8	16	100	0.204
Upnormal	5	62.5	3	37.5	8	100	
Total	10	41.7	14	58.3	24	100	
<b>PPE</b>							
Yes	4	100	0	0	4	100	0.020*
Not	6	30	14	70	20	100	
Total	10	41.7	14	58.3	24	100	
<b>Smoking</b>							
Yes	10	62.5	6	37.5	16	100	0.006*
not	0	0	8	100	8	100	
Total	10	41.7	14	58.3	24	100	
<b>Sports</b>							
Yes	2	25	6	75	8	100	0.388
not	8	50	8	50	16	100	
Total	10	41.7	14	58.3	24	100	

\*significant against the statistics

## DISCUSSION

### Measurement of Dust Levels using EPAM 5000 in a Marble Industry in Besole Village, Tulungagung

Measurement of  $PM_{2.5}$  exposures is fundamental because it is to determine the exposure to substances that can pose a health hazard. There were two workers exposed to normal lung conditions, while the statistical test of  $p$ -value = 0 was a correlation between dust levels and workers' lung conditions in a marble company in Besole Village, Tulungagung. In line with previous research, it was stated that the presence of respiratory complaints of workers exposed to and not exposed to UD X, Campurdarat District, Tulungagung with  $p = 0.005$  less than 0.05 was significant (13).

High dust levels pose a very high risk of respiratory disease (21). In addition to  $PM_{2.5}$ , the total dust content also affects pulmonary function status (4). The greater the exposure to dust in the work environment, the higher the cases of workers experiencing decreased lung function. Other factors besides dust exposure that cause a decrease in lung function status include the habit of wearing PPE, smoking, body mass index (BMI), age, years of work, and history of the disease (22-23). Pulmonary dysfunction originating from industries with high dust levels has the same symptoms and signs as lung disease that is not due to the effects of dust exposure (24) that a history of respiratory diseases such as asthma is expected and only hope for preventive efforts or work shift changes (25,26).

### Analysis of the Characteristics of Marble Workers on Lung Conditions in a Marble Company in Besole Village, Tulungagung

Age to the state of pulmonary function status indicates there is no significant association. Age is not the only factor causing the decline in workers' lung conditions. Our study showed that there was no influence between age and pulmonary function status. Besides, each respondent also has different immunity, even though they are in the same age category (9,13). In line with previous studies, using the Spearman correlation test shows a  $p$ -value of 0.368, which means there is no correlation between age and decreased lung conditions at UD X. Therefore, workers' age does not always correlate with the condition of lung function status (13). However, contrary to research conducted by Khairina, increasing age is in line with the increased susceptibility to respiratory disorders (27-28). The age factor has always been associated with the decreased progressive performance of lung function (29).

In some research results, most of the tenure is in the 13 to the 9-year category, namely ten people (41.7%), which indicates a clear relationship between

years of service and workers' lung conditions. Marble workers in Besole Village with a minimum work period of 1 year have shown many respiratory complaints, and the results of examinations show a decrease in lung conditions. It is in line with previous research, which states that workers who suffer from ARI are more during the work period >10th than workers who have worked <10th. The OR value is 11,333, the ratio of workers with a long service period >5th, and a new tenure (7). The contributing factor is that the longer a person works in a place with exposure, it will harm bodily functions, one of which is a decrease or abnormal lung function capacity (30).

Nutritional status does not affect lung conditions. In this study, marble workers did not show a difference between normal and abnormal BMI in lung conditions due to marble dust exposure. Previous research also explained that the nutritional status and cases of decreased lung conditions were not significantly related (20,28). The lungs' vital capacity because the nutrients in the body do not fully represent the state of nutritional status; several factors cause a decrease in lung capacity (22-23). The majority of Besole village marble workers have normal BMI values, namely 16 people (66.7%). Whereas those who are malnourished affect the condition of the person's immune system and body's immune system, which is decreasing; as a result, people with malnutrition are prone to infection and also reduced detoxification in the body (31).

There is a relationship between the habit of wearing PPE with lung function conditions. There are 13 people (76.5%) workers who are lazy to use PPE; marble workers in Besole Village feel uncomfortable using PPE while working. Workers tend only to use cloth wrapped around the face to minimize exposure to dust. Workers who are lazy to use PPE tend to have a disrupted lung function (23). In line with the previous research, there were 15 workers (93.7%) with a  $p$ -value = 0.017 less than (0.05), which means that the use of PPE is related to the condition of lung function at UD X. As for the contingency, value is 0.416, which means can be categorized as a moderate relationship (13). There are six people of Besole village marble workers who wear PPE when working (25%) and 18 people who do not wear PPE (75%). Adherence to PPE use is a preventive factor that results in a decrease in lung function capacity (22,30,32). Workers who obey the habit of wearing masks will minimize inhalation exposure while breathing (33). Respirators are personal protective devices that have a role in the primary intervention step. The effectiveness of using respirators in population settings is an essential subject for further prevention (5).

The majority of workers were smokers, as many as 16 workers (66.7%) and non-smokers eight workers (33.3%). In marble stone processing, the majority of workers are moderate smokers. In addition, smoking can lower the vital capacity of the lungs than other work habits. The more cigarettes smoked, the more risk of experiencing a deterioration in lung conditions (22). Smoking continuously is an opportunity to cause besides lung function. In line with previous research at UD X using the Spearman correlation test, it was obtained that p-value 0.03 was more than (0.05) so it could be concluded that there was a relationship between smoking habits and workers' lung conditions at UD X (13). The high  $H_2O_2$  content in smokers releases peroxidation compounds in unsaturated fatty acids on the cell membrane (34).

Sports habits and workers' lung function conditions have no relationship between sports habits and workers' lung conditions. Sports activity is not related to pulmonary function status. The marble processing activity is a strenuous activity that removes the slabs from the marble slabs every day. The results showed that most workers never exercise as many as 16 workers (66.7%), and eight workers exercise (33.3%). Exercise habits are very good for CVP. Getting used to exercise increases the heart rate, and blood supply to the lungs also becomes smooth so that the work of the alveoli as an oxygen exchange is maximized—sports activities at least three times a week (29).

The determination of lung condition is done using a spirometer. Measurements using a spirometer were carried out by officers who are experts in their fields at the Tulungagung Health Laboratory. The results of measurements with a spirometer will show the pulmonary function status, whether normal, restriction, or obstruction. If the predicted FVC percentage is more than = 80%, for FEV1 and FVC  $\geq$  70%, it means that the lung condition is still in a good category. If the percentage of FVC <80% for FEV1 / FVC is less than 70%, the category is restrictive. Furthermore, if the % FVC predicted, the result is the same as 80%, while FEV1 / FVC <70% means that it is in the obstructive group. If the predicted % FVC is less than 80%, FEV1 / FVC <70%, it is a combination or mixed type, namely obstructive and restrictive (2,11-12).

The study results on 24 respondents who measured lung function with a spirometer showed that nine people (75%) experienced mild restriction, and one person (8.3%) experienced moderate, severe restriction. The rest were in the category of normal pulmonary function status as many as 14 people. (58.3%). From the spirometer measurements results, there were no workers who experienced obstruction or a combination

(restriction and obstruction). There were 96 wood furniture carvers (100%) who experienced pulmonary disorders in the form of restriction, and 24 respondents (25%) had decreased obstructive pulmonary function (35). In the Guwo Lowo Puger area, specifically in Jember Regency, especially in the lime company, the results of the spirometer measurement showed that 16 respondents were two people (12.5%) with pulmonary obstruction.

## CONCLUSION

The level of marble dust that exceeds the threshold value is closely related to the condition of the workers' lungs, besides that the condition of the lungs is also affected by the working period, lousy behavior, namely the habit of not wearing PPE and smoking habits which can cause decreased lung function. It is evident that in areas exposed to dust, more lung conditions decline when compared to respondents in areas not exposed to dust.

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