ORIGINAL ARTICLE

Study of Lung Function Disorders of Headstone and Stone Mortar Crafters and Factors That Affect Them

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ABSTRACT

Introduction: Dust is one of the chemical substances that cause occupational disease, especially among stone crafters. Its deposition for a long period can lead to various health problems, hence, there is a need for early detection. Therefore, this study aims to assess the occurrence of lung function disorder in headstone and stone mortar crafters.

Methods: A cross-sectional design was used and the sample population consists of all headstone and stone mortar crafters in Allakuang Village, Sidrap Regency, Indonesia. They were selected using a purposive sampling method, and 33 out of 148 people met the criteria. Subsequently, their lung function was measured once using spirometry as well as FVC and FEV1 parameters. The data obtained were then analyzed using Chi-Square.

Results: 18 of 33 respondents with lung function disorders. They had a long tenure, a normal working time, bad exercise habits, as well as a normal and overweight nutritional status based on their BMI category. The statistical test results showed that tenure, working time, and exercise habits had an effect on the disease condition with p=0.000. Meanwhile, other factors, such as age and nutritional status had no effect with p-values of 0.981 and 0.14, respectively.

Conclusion: Based on the results, the majority of headstone and stone mortar crafters have lung function disorders, and the influential factors include tenure, working time, and exercise habits.

Keywords: Chemical hazard, Dust, Lung function, Occupational disease, Occupational health

INTRODUCTION

Occupational diseases are conditions or disorders caused by work activities or exposure to the work environment (1). The International Labor Organization (ILO) (2) stated that these diseases have a mortality rate of approximately 2.4 million per year. These diseases are also caused by several chemical compounds in nature which are often produced during the work process, and are potentially inhaled by workers, such as dust (3). Furthermore, its inhalation causes a buildup of particles in the respiratory system, which affects the airways. This further leads to various conditions, such as irritation of the respiratory tract, increased production of mucus, narrowing of the airways, loss of mucus membranes and cell layers as well as difficulty in breathing.

Based on the report issued by The Institute for Occupational Safety and Health (NIOSH) (4) published by the Center for Disease Control (CDC), approximately 92,000 workers died in the US due to respiratory tract diseases. Furthermore, the World Health Organization (WHO) (5) stated that obstructive pulmonary disease is the fifth leading cause of death and is expected to rise to the fourth position by 2030. Health and Safety Executive (6) stated that thousands of workers die from work-related lung diseases every year by breathing in certain dusts, gases, silicosis, fumes, and vapours. A previous study in home industry of produces cast aluminum also showed that 10 out of 36 workers experienced lung function disorders (7). This is in line with Pramesti et. al. (8) that 92.86% of employees had similar conditions, which were caused by dust.

Based on the results of The Surveillance of Work and Occupational Respiratory Disease (SWORD) in the UK, 3,300 cases of occupational pulmonary diseases were found among workers in large, small, and home industries. Employees in the home sectors, such as the stone industry are also susceptible to these conditions when proper work procedures are not followed (9,10).
This is consistent with Pratama and Ratna (11) that stonemasons are at risk of developing lung function disorders.

One of the most important stone crafts in South Sulawesi is the headstone and stone mortar (cobek), which are produced with a grinding machine by craftsmen in Allakuang Village, Sidrap Regency, South Sulawesi, Indonesia. The process often generates a large amount of dust that can potentially be inhaled through the nose and mouth (12), thereby causing a buildup in the lungs. Based on the preliminary observation, stone crafters often develop respiratory disorders, such as coughing, shortness of breath, and phlegm buildup.

Deposition of dust on the head or in the lungs has local or systemic effects on the body (13). Exposure for a long period can cause various diseases, hence, early detection is needed as a solution to this problem. It is also necessary to conduct a study on lung function disorders among stone crafters to develop a proper program to mitigate the severity as well as prevent the disease in the future. Therefore, this study aims to assess the occurrence of lung function disorders and factors that affect them in headstone and stone mortar crafters.

MATERIALS AND METHODS

This is a quantitative study with a cross-sectional design, which was conducted from March to November 2021. The sample population consist of all headstone and stone mortar crafters in Allakuang Village, Sidrap Regency, South Sulawesi, Indonesia. They were selected using the purposive sampling method based on the following criteria: primarily working as a headstone or stone mortar crafter, tenure of >1 year, not suffering or having a history of respiratory tract diseases, such as bronchitis, pneumonia, pulmonary tuberculosis (TB), asthma, or allergy, not smoking, and willing to be a study respondent. Based on the predetermined criteria, 33 out of 148 samples were selected. Some of the crafters met the criteria but refused to participate because of the COVID-19 pandemic. Although gender was not included as a criterion, all the participants were men. The age range of respondent was 17-65 years old. The age classification based on the Ministry of Health of Republic Indonesia on 2009, the authors use the own created questionnaire to obtain background information, included the criteria of sample selecting.

Subsequently, lung function was measured once using spirometer (Brand Minota, Type AS-507), and the FVC and FEV1 parameters were assessed. Three pulmonary function parameters were recorded as forced vital capacity (FVC), forced expiratory volume in one second (FEV1), and the ratio of FEV1/FVC. The values were taken as percentage predicted for FEV1 and FVC based on the American Thoracic Society (ATS) spirometry guidelines of 2005.

The quality control for the spirometer performed by Occupational Safety and Health Laboratory of Universitas Islam Negeri Alauddin Makassar. First, authors sorted the respondents based on the criteria, then measured the respondents once. In this case, authors used the disposable mouth-pieces to avoid contamination. All workers were sitting in a comfortable position during the measurement. Nose clips were used to avoid any leakage from the nose. Self-demonstration was provided on how to exhale air forcefully during the procedure after taking a deep breath.

The data obtained were then analyzed using Statistical Package for Social Science (SPSS) version 25 (Chi-Square). This study has obtained an ethical clearance by the Ethical Committee of the Faculty of Health Science, Universitas Sulawesi Barat under the following registration number 002b/UN55.4/KOM.ETIK/2021.

RESULTS

Based on the measurement results on headstone and stone mortar crafters, the majority of them experienced lung function disorders, as shown in tables. Based on the Table I, most of the respondent are adults (26-45 years old), elementary school graduates, and not smoking, also all of the crafters are male. Furthermore, based on Table II, most of the respondents had lung function disorders (54.5%) with the mean of 71.542, median of 74.1, and standard deviation of 19.6913.

Most of the participants with a long exposure period experienced the disease, as shown in tables. Based on the data, the samples were classified into 2 groups, namely long tenure of ≥5 years and short tenure of <5 years (14). Furthermore, 17 of 20 have long tenure experienced the lung function disorders. According to the statistic test, a p-value of 0.000 was obtained, indicating that tenure is an influential factor for lung function disorder among crafters.

Table I: Respondent Characteristics

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Young (17-25 years old)</td>
<td>4</td>
<td>12.1</td>
</tr>
<tr>
<td>Mature (26-45 years old)</td>
<td>20</td>
<td>60.6</td>
</tr>
<tr>
<td>Old (46-65 years old)</td>
<td>9</td>
<td>27.3</td>
</tr>
<tr>
<td><strong>Level of Education</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elementary school</td>
<td>16</td>
<td>48.5</td>
</tr>
<tr>
<td>Junior High School</td>
<td>7</td>
<td>21.2</td>
</tr>
<tr>
<td>Senior High School</td>
<td>10</td>
<td>30.3</td>
</tr>
<tr>
<td><strong>Smoking Status</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>No</td>
<td>33</td>
<td>100</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>33</td>
<td>100</td>
</tr>
</tbody>
</table>
Meanwhile, the majority of the participants with a normal working time had no lung function disorders. According to the Republic of Indonesia Government and United States Department of Labor, the regular working duration is 8 days per week as stated by (15,16). Among the 22 crafters with a normal working time, 7 experienced the condition, while the remaining 15 did not experience the condition. In addition, 11 of them with an abnormal duration had lung function disorders. From the statistical test, a p-value of 0.000 was obtained, which indicates that tenure is an influential factor in the disease.

The results showed that most of the adult (26-45 years old) participants had lung function disorders, where 2 out of 4 youngsters, 11 of 20 adults as well as 5 of 9 aged crafters were affected. In this case, the age classification is based on the Ministry of Health of the Republic of Indonesia on 2009(17). Based on the statistical test, a p-value of 0.981 was obtained, indicating that exercise habits is an influential factor among crafters.

The majority of samples with normal and overweight nutritional status suffered from lung function disorders. According to WHO (19), BMI was categorized into four classes. In this case, 1 of 3 is underweight, 5 of 16 are normal, and 11 of 13 participants had overweight nutritional statuses, respectively, all experienced the disease along with one crafter with obesity. Based on the statistic test, a p-value of 0.14 was obtained, nutritional status had no effect on lung function disorder among the workers.

**DISCUSSION**

Based on the results of the examination using spirometry with FEV1/FVC parameters, most of the headstone and stone mortar crafters had lung function disorders. Several respondents also experienced complaints, such as coughing, fever, shortness of breath, chest pain, and phlegm discharge in the morning. The results showed that crafters working in a dusty environment are prone to diseases related to respiratory or pulmonary disorders because granite is one of the raw materials they use for the production. A previous study on marble stone

<table>
<thead>
<tr>
<th>Lung Function Disorders</th>
<th>n</th>
<th>%</th>
<th>Mean</th>
<th>Median</th>
<th>Standard Deviation</th>
<th>Interquartile Range (IQR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes (FEV1/FVC ≤75%)</td>
<td>18</td>
<td>54.5</td>
<td>71.542</td>
<td>74.1</td>
<td>19.6913</td>
<td>32.19</td>
</tr>
<tr>
<td>No (FEV1/FVC &gt;75%)</td>
<td>15</td>
<td>45.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variable</th>
<th>Category</th>
<th>Lung Function Disorders</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Yes (n (%))</td>
<td>No (n (%))</td>
</tr>
<tr>
<td>Tenure</td>
<td>Long (≥5 years)</td>
<td>17 (51.5)</td>
<td>3 (9.1)</td>
</tr>
<tr>
<td></td>
<td>Short (&lt;5 years)</td>
<td>1 (3.0)</td>
<td>12 (36.4)</td>
</tr>
<tr>
<td>Working Time</td>
<td>Normal (≤ 8 hours/day)</td>
<td>11 (33.3)</td>
<td>0 (0)</td>
</tr>
<tr>
<td></td>
<td>Abnormal (&gt; 8 hours/day)</td>
<td>7 (21.2)</td>
<td>15 (45.5)</td>
</tr>
<tr>
<td>Age</td>
<td>Young (17-25 years old)</td>
<td>2 (6.1)</td>
<td>9 (33.3)</td>
</tr>
<tr>
<td></td>
<td>Adult (26-45 years old)</td>
<td>11 (37.3)</td>
<td>9 (33.3)</td>
</tr>
<tr>
<td></td>
<td>Old (46-65 years old)</td>
<td>5 (15.2)</td>
<td>4 (12.1)</td>
</tr>
<tr>
<td>Exercise Habit</td>
<td>Good (at least once exercise a week)</td>
<td>3 (9.1)</td>
<td>12 (36.4)</td>
</tr>
<tr>
<td></td>
<td>Poor (no exercise in a week)</td>
<td>15 (45.5)</td>
<td>3 (9.1)</td>
</tr>
<tr>
<td>Nutritional Status</td>
<td>Underweight (BMI &lt;18.5)</td>
<td>1 (3.0)</td>
<td>2 (6.1)</td>
</tr>
<tr>
<td></td>
<td>Normal (BMI 18.5-24.9)</td>
<td>5 (15.2)</td>
<td>11 (33.3)</td>
</tr>
<tr>
<td></td>
<td>Overweight (BMI 25-29.9)</td>
<td>11 (33.3)</td>
<td>2 (6.1)</td>
</tr>
<tr>
<td></td>
<td>Obese (BMI ≥30)</td>
<td>1 (3.0)</td>
<td>0 (0)</td>
</tr>
</tbody>
</table>

Table II: The value of FEV1/FVC measurement on headstone and stone mortar crafters

Table III: The factors that affect lung function disorders in headstone and stone mortar crafters
workers in Myanmar revealed that these conditions have led to the occurrence of similar diseases (20). This study also found that workers in different workplace (cobblestone paving workers, kaolin, gold mine, quarry, stone cutting) were exposed to higher levels of dust (21,22).

Furthermore, most of the affected headstone and stone mortar crafters in Allakuang Village worked in an arid locality, where the soil is prone to lifting due to the dry condition (23). Based on the field observation, the intensity of dust in these areas was significantly higher than in others, hence, they must be supported with objective measurement. Airborne dust increases the risk of exposure and respiratory diseases, and this is in line with Abidin et al. (7) exposures below the NAB level can still cause lung function disorders.

WHO (13) data showed that dust with a size of 0.1-5 or 10 microns are very hazardous to the respiratory tract. Furthermore, particles of 5-10 microns are obstructed by the upper respiratory tract, 3-5 microns are kept in the middle of the airway, while 1-3 microns can freely enter the lung tissue (24). However, in this study, authors did not measure the size of dust due to existing dan mobilization equipment.

The occurrence of lung function disorder is influenced by various factors, such as individual proneness as well as the amount of exposure to the body. Ardam (25) revealed that there is a strong positive relationship between the intensity of inhalation and pulmonary diseases, and this is consistent with the results of several studies, such as Armaeni dan Widajati (26), and Wahyuni et al. (27). However, Wulansari (28) obtained a different result, where there was no association.

Several factors affect the occurrence of lung function disorders among headstone and stone mortar crafters, such as tenure, working time, and exercise habits, as shown in Table 3. People with a tenure of ≥5 years as well as longer working hours are more exposed to chemicals substances, which can lead to disorders and dust buildup in the lung tissue (29). Suma’mur (14) revealed that the longer a worker stays in a dusty environment, the more severe the deposition that occurs. Continuous exposure to chemicals, such as dust in the workplace, even at a low dose is still detrimental to the body (30).

This study’s results are in line with Amerta and Wirawan (31) that there is a significant relationship between tenure and lung function disorders. Similar results were also obtained by Juno (32), where workers with a working duration of >4 years experienced the condition. However, the results are inconsistent with Sinaga (33), which reported the absence of an association. This was assumed to be caused by the difference in tenure categorization, where Sinaga used >7 years and ≤7 years.

In terms of duration, the majority of the crafters work for ≤8 hours a day, which is normal. However, it can still cause daily dust accumulation, which increases the risk of lung function disorders. Sari et al. (34) revealed that working time had an effect on lung function disorders in ceramic workers in Medan. Similar results were also obtained by Kabir et al. (35) among stone workers in Bangladesh where they experienced the condition due to stone dust particulates.

The particles can mix with grinding dust from other sources within the same location as several crafters work in the same location. Headstone and stone mortar crafters with lung function disorders have a long working time, which increases the accumulation as well as the risk of clogging. Abidin et al. (7), stated the longer the duration of exposure, the higher the damage to the respiratory tract. This condition is exacerbated by the workplace condition. Although crafters are exposed to dust from their working place daily, the rate of Personal Protective Equipment (PPE) non-compliance is still very high. Most of the workers often put off their masks due to breathing difficulty, which inevitably leads to inhalation of harmful particles.

However, several crafters make efforts to mitigate the risk of lung function disorders by using running water during work as well as wearing moistened PPE. Moisturized dust has a heavier overall mass or weight, which causes clumping, and quick deposition on the ground, thereby preventing airborne particles. Farhadloo et al. (36) revealed that the oldest method for controlling dust is the application of water, which increases its weight and limits the movement in air. This method can be used to reduce the amount of particles inhaled by the crafters.

This study’s results are in line with Apsari et al. (37) that working time has an effect on lung function disorder, where crafters with a longer duration are at higher risk of experiencing the condition. Similar results were obtained by Amerta and Wirawan (9), where the risk was higher for workers with a duration of ≤8 hours, Nabuasa et al. (38) stated that the possibility of decreased lung function is greater can be seen by the longer a worker spends working in the dusty area, the more exposure to dust they receive.

In terms of exercise habits, the majority of the crafters were in the poor category. This indirectly increases their susceptibility due to the effect of the factor on lung capacity. Several studies revealed that there is a positive correlation between the level of exercise and lung function (39). Bagus et al. (40), revealed that the human body, especially the muscles, requires a regular and stable supply of energy and fuel during physical activities. Therefore, oxygen is needed as a fuel for energy production, and to meet this need, the body must respond with a compensatory mechanism, namely increasing the frequency of respiration. This also
increases the efficiency of ventilation, which raises the vital capacity of the lung.

The results showed that several crafter had good exercise habits, such as playing badminton, football, takraw, volleyball, and jogging during their free time after work or during an off-day, namely Fridays. Physical activities, such as jogging, also help to improve the respiration system. Running during a futsal or other sports leads to the contraction of the diaphragm, which is the main muscle of respiration below the base of the lungs (41). The result also showed that lung vital capacity is closely associated with exercise because a good condition reduces the rate of tiredness. However, when the organ is contaminated with toxic substances, this causes a decrease in its function and capacity (42). This finding is in line with Fithri’s (43) study that exercise habits have a positive effect on lung function disorders.

CONCLUSION

Based on the results, the majority of headstone and stone mortar crafters have lung function disorders, and the influential factors include tenure, working time, and exercise habits. According to the Hierarchy of Control, the situation can be managed with engineering control, such as the use of a guard on the grinding machine to prevent dust as well as the continuous addition of water. However, the workers must pay attention to the condition of the machine while using this method. Crafters can carry out administrative control, such as reducing the duration of exposure, improving exercise habits, and having a routine health check at least once a year. They are also expected to use PPE according to standards.

ACKNOWLEDGEMENTS

The authors are grateful to the headstone and stone mortar crafters in Allakuang Village, Sidrap Regency, Indonesia for their contribution. The authors are also grateful to the Ministry of Education and Culture as well as the National Agency for Research and Innovation, Republic of Indonesia for the study grant funds (070/E4.1/AK.04.PT/2021).

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