

Original Article

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Prevalence of pulmonary function impairment among the stone quarry workers of Sylhet region

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Abstract:

Background: Stone Quarry is an unorganized sector that involves various processes that produce dust particles of silica and heavy metals. Inhalation of these dust particulates causes serious respiratory difficulties. Respiratory problem is one of the major health hazards in dust-exposed workers; it is a major cause of morbidity and mortality all over the world.

Materials and methods: This study was a cross-sectional observational study. The study was carried out in the stone quarries of Companiganj and Gowainghat Upozilla, Sylhet during the time period of 1st March, 2022 to 29th February, 2023. Workers in the age range of 25 years to 65 years and those who have been working for at least five years in the quarry were included in the analysis. Convenient sampling method was used to recruit the required number of respondents in the study.

Results: Total 200 participant with the age range of 25 to 65 years were included in the analysis with the mean age of 45.57(SD $\pm$ 11.48) years. Among male and female, 65.5% (n=131) were male and 34.5% (n=69) were female. Among the quarry workers, 53% were smoker and 47% were non-smoker. Among the different service length 59% have a service length of 5-10 years, 21.5% and 19.5% have more than 10-15 years & >15 years respectively. Among the 200 workers, 39% (n=78) were diagnosed as non-reversible obstruction (NR) that is COPD and 5.5% (n=11) have reversible obstruction. Restrictive pattern was found in 18% (n=36) and 37.5% (n=75) has normal lung function.

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Conclusion: Chronic exposure to dust in stone crushing Industry may increase the risk of respiratory problems and impaired lung function; cigarette smokers, long duration of daily exposure and non-usage of Personal Protective Equipment (PPE) are at higher risk.

Key words: Quarry workers, pulmonary function impairment, health hazard.

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Introduction:

Workplace is an important factor affecting worker's respiratory health.¹

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The workplace health hazard and safety issues get less attention in public health discourse, academic debates and health policies in Bangladesh. Exposure to dust is a well-known phenomenon, especially in developing countries. The inhaled dust particles could cause lung injury as a result of this exposure. Quarry dust carries 71% silica, which on inhalation causes silicosis, an irreversible lung condition in quarry workers.² Also, it progresses even after exposure is discontinued.² It has been shown that people who work in dusty environments run the risk of breathing particulate matters that may cause

respiratory problems such as restrictive disorders. Additionally, there have been reports of a high prevalence of silicosis among Indian quarry employees who work with shale sedimentary rock.² There have been numerous reports of significant pulmonary function deficits in quarry workers.³ A study conducted in Palestine on stone cutters showed that there were 21.6% of cases of abnormal pulmonary function tests, 20.1% of whom had restrictive pulmonary illnesses, and 1.5% of whom had obstructive lung disorders. Predominantly, there was a significant rise in the percentage of workers with abnormal pulmonary function tests as length of exposure increased, with abnormal pulmonary function tests occurring in 16.1%, 20.9%, and 36% of workers with exposure durations of 0–10 years, 11–20 years, and >21 years, respectively.⁴ According to numerous studies,^{5,6,7} quarry workers who are exposed to respirable quarry dust are more likely to acquire respiratory conditions. In India, Shrivastava et al. documented cases of respiratory symptoms among exposed stone carvers, and complaints of shortness of breath, cough, and chest pain were present among 26%, 19% and 2% of the workers, respectively.⁵ Kabir et al,⁶ reported that in Bangladesh, 2.5% of workers in the stone crushing industries experienced restrictive pulmonary disorder. In Brazil, the prevalence of respiratory symptoms among employees was 22.44%, and around 17.69% of workers had reduced pulmonary function as indicated by the spirometer.⁷ Crystalline silica is found in stone, rock, sand, gravel and clay, as well as products such as bricks, tiles, concrete, artificial stone benchtops and some plastic materials. When these materials are worked on, the silica is released as a fine dust. This dust is respirable crystalline silica commonly called silica dust.⁸ It has been found that crystalline silica is more dangerous because of its needle like structure which is cytotoxic and produce highly reactive surface radicals after grinding which favours the adsorption of surface materials. The severity of diseases depends upon the size, shape, concentration of particles and duration of exposure.⁹ The air of quarry area is composed of abundant particulate substance of silica dust. The workers of stone quarry are exposed to silica dust of different concentration and

particulate size. Average dust levels vary from about 0.04mg/m³ to over 5mg/m³. A study suggested that loss of lung function occurs with exposures to silica dust at concentration of between 0.1 and 0.2mg/m³.¹⁰ Moreover, inhalation of silica dust for long periods can causes focal and interstitial fibrosis, centrilobular emphysema and progressive massive fibrosis of lungs.¹¹ It is also found that workers exposed to silica have an increased risk of chronic bronchitis as a consequence of non-specific effects of dust.¹² The workplace health hazards are an important public health issue and are avoidable through preventable intervention in the workplace. Although the developed nations have taken few steps forward to ensure safe and healthful working conditions by setting and enforcing standards, Bangladesh is still lagging behind. Therefore, the purpose of this study is to determine the prevalence of pulmonary function impairment among the stone quarry workers of Sylhet region.

Methodology:

This study was a cross-sectional observational study. The study was carried out in the stone quarries of Companiganj and Gowainghat Upozilla, Sylhet. The study was carried out during the time period of 1st March, 2022 to 29th February, 2023. Workers in the age range of 25 years to 65 years and those who have been working for at least five years in the quarry were included in the analysis. Ethical clearance was taken from the ethical review committee of Sylhet MAG Osmani Medical College prior to commencement of study. Informed written consent was taken from the patient and study related information was explained in local language to patient. The purpose and method of the study, confidentiality of the interviews, risks and benefits of participating in the study, respondent's right to participate voluntarily and right to withdraw at any point was explained in the local language from a printed handout. Convenient sampling method was used to recruit the required number of respondents in the study. Workers were interviewed face to face using the semi-structured questionnaire. Baseline spirometry was performed for all the participants of the study. Spirometry was carried out using a calibrated portable spirometer. Spirometry was

done with participants sitting at ambient temperature and after at least 10 minutes of rest. The subjects were asked to exhale into the spirometer as forcefully as possible after maximum inspiration. The parameters measured was forced vital capacity (FVC) and forced expiratory volume in one second (FEV1). FEV1/FVC ratio will be calculated from the measured data. Study participants with value of FEV1/FVC of less than 0.7 was examined with post-bronchodilator test according to the ATS / ERS guideline, 15 minutes after the administration of 400 micrograms of salbutamol. Normal spirometry indicates that all measured parameters (FVC, FEV1, and FEV1/FVC) are 80% or higher than the predicted values compared to their sex, age, height, weight, and ethnicity. An obstructive pattern means that FEV1 is lower than 80% of the predicted value, FVC is reduced but to a lesser extent than FEV1, and the ratio is also reduced to lower than 70%. A restrictive pattern means that both FEV1 and FVC are reduced to lower than 80% of the predicted value, and the ratio is normal (above 70%).

Results:

A total of 200 quarry workers participated in the study. The age of the respondents ranged from 25 to 65 years, with a mean of 45.6 years (SD ± 11.5). The largest proportion of workers (30.0%) were in the 55–65 year age group. Males comprised nearly two-thirds of the study population (65.5%, $n=131$), while females accounted for 34.5% ($n=69$). In terms of educational background, the majority of respondents (83%) were illiterate, 14.5% had completed primary education, and only 2.5% had reached secondary level.

With respect to occupational characteristics, most workers (59.0%) had been employed for 5–10 years, while 21.5% had a service length of 10–15 years, and 19.5% had more than 15 years of experience. More than half of the respondents (53%) reported being smokers.

The use of protective equipment was found to be extremely limited: only 13% ($n=26$) of the workers reported using any form of protection,

whereas the vast majority (87%, $n=174$) did not use protective measures during work.

Regarding pulmonary function status, 39% ($n=78$) of workers were diagnosed with non-reversible obstruction consistent with COPD, while 5.5% ($n=11$) had reversible obstruction. A restrictive pattern was observed in 18% ($n=36$) of workers, whereas 37.5% ($n=75$) had normal lung function.

Table 1 Socio-demographic characteristics of quarry workers.

Characteristics	Frequency	Percent
Age (years)		
25-34	40	20.0
35-44	55	26.50
45-54	47	23.50
55-65	60	30.00
Sex		
Male	131	65.5
Female	69	34.5
Educational Qualifications		
Illiterate	166	83.0
Primary	29	14.5
Secondary	5	2.5

Table 2: Distribution of respondents according to the length of service and smoking status.

Characteristics	Frequency	Percent
Working Length		
5-10 Years	118	59.0
>10-15 Years	43	21.5
15+ Years	39	19.5
Smoking Status		
Smoker	106	53.0
Non smoker	94	47.0

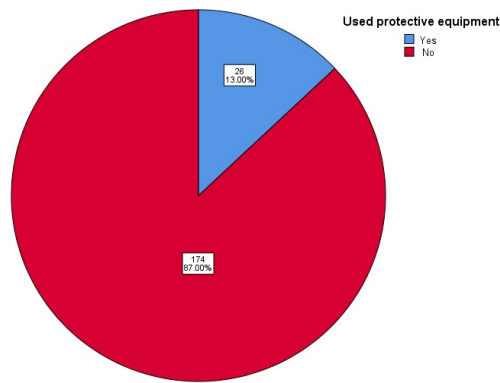


Figure 1: Distribution of respondents based on Protective equipment using (n=200)

Table 3: Distribution of respondents based on pattern of lung function (n=200)

Pattern	Frequency	Percent
Obstruction (Non reversible)	78	39.0
Obstruction (Reversible)	11	5.5
Restriction	36	18.0
Normal	75	37.5
Total	200	100

Discussion:

The study revealed that a significant proportion (39%) of quarry workers had non-reversible obstruction, i.e., COPD, among the 200 participants exposed to silica dust. This may be the result of the cumulative effects of silica exposure, smoking, prolonged contact with quarry dust, lack of protective measures, and long hours of daily work. This finding is comparable to studies conducted in Peshawar, Pakistan, and Wales, UK, where 35% of workers in dust-generating industries in Peshawar and 33% of slate mining workers exposed to silica dust in Wales were found to have COPD.^{9,13} Another study demonstrated that the decline in lung function values was significantly greater among individuals with both silica and tobacco exposure compared with those with only smoking exposure.³ The synergistic effect of tobacco smoke and occupational silica dust exposure on COPD development has been well documented in several other studies.^{9,14} Among the different patterns of lung function, we found that 18% of the workers had a restrictive pattern. This finding is consistent with a study conducted

at the Umuoghara quarry site in Ebonyi State, Nigeria, which reported a 14.3% prevalence of restrictive disorder and 10.7% with obstructive patterns of lung function.¹⁵ Similarly, a study in Kenya on quarry workers reported a restrictive disorder prevalence of 12.7%.¹⁶ However, the prevalence of restrictive disorders varies across studies globally, reflecting differences in occupational practices, exposure levels, and regional health and safety measures. For instance, a study in Bangladesh reported only 6.7% obstructive and 2.5% restrictive pulmonary disorders.¹⁷ The lower prevalence in that study may be explained by the shorter duration of exposure, as 95.3% of the quarry workers had less than five years of work experience. In contrast, in our study, a higher proportion of workers had more than five years of experience, which likely contributed to the higher prevalence of both obstructive and restrictive disorders. On the other hand, studies from other regions have reported much higher rates. In Wardha District, India, a prevalence of 31.04% was observed,¹⁸ while in Pakistan, 34% of workers exposed to crystalline silica in marble dust were found to have restrictive pulmonary impairment.¹⁹ These findings highlight the hazardous nature of silica dust exposure and suggest that differences in work conditions, levels of dust exposure, and the use of protective measures contribute to variations in prevalence. Several other studies also support the significant burden of restrictive disorders among quarry workers exposed to respirable silica dust. With regard to protective equipment, we found that only 13% of workers reported using protective equipment while working. None of the respondents reported having access to medical facilities at their workplace. This reflects a complete absence of occupational health care and a near-total lack of protective equipment use in the study area. A similar observation was made in a study from India, which showed that quarry workers using protective measures were less likely to develop restrictive lung disorders compared to those who did not.²⁰ Another study reported that 98.3% of quarry workers failed to adopt safety procedures or wear personal protective equipment,² and found a significant association between lack of protective measures and pulmonary function impairment. The low

compliance with safety measures may be due to poor working conditions, as workers often find protective equipment uncomfortable to wear under the sun. Overall, the findings of this study demonstrate that pulmonary function impairment is highly prevalent among quarry workers. The results further indicate that the duration of exposure, smoking, and lack of protective measures are key factors significantly associated with lung function impairment.

Conclusion:

The prevalence of pulmonary function impairment was found to be significant among quarry workers. The findings of this study highlight the need to raise awareness about respiratory health problems among workers in the stone-crushing industry in Bangladesh. Policymakers should adopt appropriate strategies to support quarry workers and promote awareness (e.g., encouraging the use of protective equipment during work) in order to reduce occupational health risks.

Limitations:

1. The dust concentration within the industrial environment was not measured due to a lack of instruments and resources.
2. The type of silica present in the workplace was not evaluated.
3. As this was a cross-sectional study without a control group, causal associations could not be confidently established.

Verification of PPE use and confirmation of the length of employment of individual workers were not possible due to the unavailability of records.

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