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Lung Function Impairment and Workplace Control Measures among Marble Stone Carvers in Sa-Kyin Village, Madayar Township, Myanmar

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Abstract

Introduction: Marble rocks, composed of dust containing calcium carbonate and silica particles, predispose to a higher prevalence of occupational lung diseases. This study aimed to assess workplace control measures and lung function impairment among marble stone carvers.

Methods: A cross-sectional descriptive study was conducted among 120 marble stone carvers in Sa-Kyin Village, Madayar Township in May 2019. Information about existing control measures in the workplace was assessed using a pre-tested structured questionnaire and participants' lung function using spirometry. Respirable dust measurements in twelve randomly selected workers were performed by personal air sampling pumps.

Results: It was found that 9.2% of marble stone carvers used disposable or cloth masks throughout the working time, but no one was found using appropriate devices like respirators. No one reported about regular medical checkup and provision of health education at the workplaces. Spirometry testing showed 55.8% had lung function impairment. Concentrations of respirable dust ranged from 7.19 to 10.13 mg/m^3, significantly higher than the recommended Threshold Limit Value (3 mg/m^3). In multivariable logistic regression analysis, development of lung function impairment was associated with age [adjusted Odds Ratio (aOR) = 2.84; 95% CI = 1.02,7.91] and use of face mask (aOR = 0.11; 95% CI = 0.01,0.91).

Conclusion: The working environment was found dusty, and a significant proportion of workers had lung function impairment. It is essential to adopt proper dust control measures in stone carving workplaces. Preventive measures like medical surveillance and health education program are vital to reduce the burdens from occupational lung diseases.

Key words: Lung function test, Marble, Occupational disease

Introduction

Occupational lung diseases due to exposure to dust are one of the major health hazards.[1] Occupational dust exposure leads to a greater prevalence of lung function impairment.[2] Marble rocks are composed of dust containing calcium carbonate and silica particles that can cause lung diseases, including occupational asthma, chronic obstructive pulmonary disease (COPD), silicosis and cancer.[3,4]

Globally, it is estimated that there are 2.3 million deaths annually due to diseases attributed to the workplace in 2012.[5] The prevalence of silicosis is extremely high, and more than 5 million people are exposed to respirable silica dust globally.[6] Approximately 15% of COPD, 11% of asthma, and 9% of cancer were reported worldwide in 2000.[7] In the UK, the prevalence of occupational COPD was 10% for males and 11% for females in 1990, and the prevalence of pneumoconiosis accounted for 9% of the total number of occupational lung disease in 1997.[8] Eighteen percent of workers in

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Vietnam and 55% of workers in India engaged in coal mining and quarrying of sedimentary rock have been found to have silicosis.[9]

Lung function assessment using spirometry is an invaluable screening test, which is performed to monitor the effects of occupational/environmental exposures.[10] The best practice to assess dust exposure is to use the personal sampler, which can estimate the workers' average dust exposure.[11]

Most work processes may cause significant dust exposure, leading to serious health risks if it is not properly planned, controlled, and managed. The health hazard is not entirely linked to occupations but linked to the working environment and improper use of protective measures.[11] Prevention is vital for decreasing the incidence of morbidity and disability from occupational lung diseases.[12]

Sa-Kyin Village is located in Madayar Township, 21 miles to the north of Mandalay. It has a population of nearly 7,000 living in 1,500 households. More than 60 percent of the households depend on carving statues as an occupation. This study aimed to determine the workplace control measures in the working environment, assess lung function impairment among marble stone carvers, and measure dust concentration in selected workplaces.

Methods

A cross-sectional descriptive study was carried out in Sa-Kyin Village, Madayar Township, Myanmar during May 2019. Marble stone carvers working in marble stone carving workplaces for more than one-year duration were included. The required sample size (n=120) was calculated at a 95% confidence interval, with the degree of precision at 0.09 level, which was based on the 64% prevalence rate of abnormal lung function test among the gold miners in Myanmar in 2016.[2] There were around 700 marble stone carving workplaces in the Sa-Kyin Village. Among them, 120 workplaces were selected randomly for this study. One marble stone carver was chosen at each workplace by the lottery method for the interview and measuring lung function test.

The data collection tools included a pre-tested structured questionnaire, spirometry, and personal air sampling pump. The questionnaire included socio-demographic and work characteristics and workplace control measures. Content validity of the questionnaire was approved by a specialist from the Occupational and Environmental Health Department and 20 stone carvers with a similar background to the target population were pre-tested before data collection.

Spirometry testing

Lung function assessment was tested using spirometry (Vitalograph Alpha Touch) supported by the Occupational and Environmental Health Department, Ministry of Health and Sports (MOHS), Myanmar. The procedure was performed by a trained technician from this department and validated by the Occupational Safety and Health Association (OSHA) recommendation. In spirometry testing, FVC (forced vital capacity), FEV1 (forced expiratory volume in one second) and FEV1/FVC ratio were recorded. Lung function was categorized into normal (FEV1/FVC ≥ LLN, FEV1 ≥ LLN and FVC ≥ LLN) and impaired (obstructive pattern – FEV1/FVC < LLN and FEV1 < LLN, restrictive pattern – FEV1/FVC ≥ LLN and FVC < LLN).[13] The values recommended by OSHA were used as reference values, which were based on spirometry data collected by the NHANES III (National Health and Nutrition Examination Surveys III) published in 1999. Caucasian values for FVC and FEV1 were multiplied by 0.88 to adjust those for Asian workers.[14]

Dust concentration measurement

A personal air sampling pump was used to measure the respirable dust concentration exposed to the marble stone carvers over 8 hours. Twelve randomly selected marble stone carvers were chosen for measurement. The sampler was attached to the worker's upper chest, not more than 30 cm away from the nose-mouth region. The instrument used was the air sampling pump (Airchek sampler), supported by the Occupational and Environmental Health Department, MOHS, Myanmar.

Data management and analysis

Data entry and analysis was done using SPSS Version 25 software. Mean, standard deviation, frequency and percentage were used as descriptive statistics, and Pearson's Chi-square test was used as inferential statistics. Multivariable logistic regression analysis was applied in assessing the predictors of lung function impairment. Variables like socio-demographic and work characteristics and workplace control measures were the independent variables. Those variables whose p-value was ≤0.25 in univariate analysis were selected as candidate variables for multivariable analysis.

Ethical consideration

This study was reviewed and approved by the Academic and Ethical Board of the University of Medicine, Mandalay, Myanmar. (ID No. 277/UMM/2019)

Results

In this study, the participants were aged 18 to 51 years, and the mean age was 30.45 years (SD±9.33). Most of the participants (92.5%) were male and current smokers were 50.8%. Four stone carvers (3.3%) had a previous history of respiratory diseases, where three had asthma, and the other had tuberculosis. Socio-demographic and work characteristics were described in Table 1.

While assessing the existing control measures in the workplaces, only 9.2% of marble stone carvers used disposable or cloth masks throughout the working time, but no one was found using appropriate respirators. Seventy percent of workers never used any protective measures to prevent dust exposure, and the reasons were that the use of these makes them feel hot, breathless, and uncomfortable to wear. They also believed that marble dust exposure would not have any severe effects on them. No employer supported the personal protective equipment to the workers in the workplaces. No one reported about regular medical checkup and provision of health education at the workplaces. Out of 120 workplaces, 63.3% did not use any control measures in the working environment, whereas the remaining applied wet methods, including wet drilling and water spraying onto marble stones' cutting surfaces. There were no workplaces that applied general ventilation and local exhaust ventilation. All marble stone carvers worked outdoors or under the buildings with the roof to cover the sun. Besides, no marble stone carvers joined the Social Security Board, Myanmar for workers' benefits and contributions. Dust concentration had never been checked in the workplaces.

The mean measurement of respirable dust concentration in selected workplaces was 8.78 mg/m^3 (SD±0.90), ranging from 7.19 to 10.13 mg/m^3. In lung function testing, 44.2% of participants showed normal spirometry results, whereas 55.8% showed the impaired results, with 49.2% as the restrictive pattern and 6.7% as the obstructive pattern.

The results of univariate and multivariable logistic regression analyses in assessing the predictors of lung function impairment were shown in Table 2. The variables which are included in the final model were age and use of face masks. Marble stone carvers above 40 years of age were nearly three times more likely to develop lung function impairment than their counterparts (aOR = 2.84; 95% CI = 1.02,7.91). Marble stone carvers who did not use face masks were 89% less likely to have lung function impairment. (aOR = 0.11; 95% CI = 0.01,0.91).

Table 1: Frequency distribution of socio-demographic and work characteristics among marble stone carvers (n=120)

Socio-demographic characteristics	Frequency	Percent	P-value
Age			
<40 years	96	80.0	0.000
≥40 years	24	20.0	
Sex			
Male	111	92.5	0.000
Female	9	7.5	
Education status			
No formal education	2	1.7	0.000
Primary school	51	42.5	
Middle school	50	41.7	
High school	15	12.5	
University/Graduate	2	1.6	
Smoking status			
Non-smokers	59	49.2	0.855
Current smokers	61	50.8	

Underlying respiratory diseases			
Yes	4	3.3	0.000
No	116	96.7	
Years of employment			
≤5 years	37	30.8	0.031
6-10 years	30	25.0	
>10 years	53	44.2	
Working hours			
<8 hours	53	44.2	0.235
≥8 hours	67	55.8	
Size of work			
Small (≤5 workers)	37	30.8	0.622
Medium (6-10 workers)	38	31.7	
Large (>10 workers)	45	37.5	

Table 2: Results of univariate and multivariable logistic regression analyses in assessing the predictors of lung function impairment (n=120)

Potential predictors	Lung Function Impairment		Crude OR	95% CI	Adjusted OR	95% CI
	Present N (%)	Absent N (%)				
Age						
<40 years	49 (51.0)	47 (49.0)	Ref		Ref	
≥40 years	18 (75.0)	6 (25.0)	2.87	1.05-7.88	2.84*	1.02-7.91
Sex						
Female	5 (55.6)	4 (44.4)	Ref		NA	
Male	62 (55.9)	49 (44.1)	1.01	0.26-3.97		
Education status						
High	12 (70.6)	5 (29.4)	Ref		NA	
Low	55 (53.4)	48 (46.6)	0.48	0.16-1.45		
Smoking status						
Non-smoker	36 (61.0)	23 (39.0)	Ref		NA	
Current smoker	31 (50.8)	30 (49.2)	0.66	0.32-1.36		
Underlying respiratory diseases						
No	64 (55.2)	52 (44.8)	Ref		NA	
Yes	3 (75.0)	1 (25.0)	2.44	0.25-24.13		
Year of employment						
≤5 years	18 (48.6)	19 (51.4)	Ref		NA	
>5 years	49 (59.0)	34 (41.0)	1.52	0.69-3.32		
Working hour						
<8 hours	28 (52.8)	25 (47.2)	Ref		NA	
≥8 hours	39 (58.2)	28 (41.8)	1.24	0.60-2.56		
Size of work						
Small	23 (62.2)	14 (37.8)	Ref		NA	
Others	44 (53.0)	39 (47.0)	0.69	0.31-1.52		
Use of face masks						
Use	10 (90.0)	1 (9.1)	Ref		Ref	
Not use	57 (52.3)	52 (47.7)	0.11	0.01-0.89	0.11*	0.01-0.91
Dust control measures						
Present	21 (47.7)	23 (52.3)	Ref		NA	
Absent	46 (60.5)	30 (39.5)	1.68	0.79-3.55		

*p-value <0.05

Discussion

A cross-sectional descriptive study was carried out to assess workplace control measures and lung function impairment among marble stone carvers in Sa-Kyin Village, Madayar Township, Myanmar. One hundred and twenty marble stone carvers were included in this study.

Concerning the use of personal protective measures (face masks or respirators), only 9.2% used them always throughout the working time. They used ordinary cloth masks or disposable surgical masks, but no one used proper protective devices like respirators. In a previous study in a cement factory of the United Arab Emirates, nearly a quarter claimed to use masks all the time even though personal protective equipment were available for all factory workers.[15] Likewise, a study among marble cutting workers reporting the use of personal protective measures was only 5%. However, after intervention measures and health education sessions two times, their use among workers rose from 5% to 57.8%. Therefore, this study strongly suggested performing interventions such as health education and training sessions to increase the use of preventive measures effectively among the workers in dusty jobs.[3]

A total of twelve respirable dust measurements were performed, and the concentration ranged from 7.19 to 10.13 mg/m^3. All the measurements exceeded the recommended Threshold Limit Value (TLV) based on the American Conference of Governmental Industrial Hygienists (ACGIH) for low toxicity, 3 mg/m^3. Based on this finding, the study site's working environment is dusty and hazardous for the workers. The mean concentration of respirable dust in cement production in Iran was 11.9 mg/m^3 (SD±14.7), which was also higher than the recommended TLV.[16] However, 22 measurements were performed in the Greek cement production, and they were below the TLV established in Greece.[17] Generally, the dust concentration level in the working environment depends on the types of dust control measures adopted in the workplaces. Therefore, it can be concluded that there were still weaknesses in the dust control measures in the study site so that it would be necessary for the authorities to enforce the monitoring and regulations in the workplaces.

Spirometry results showed lung function impairment in 55.8% of marble stone carvers. The prevalence of restrictive pattern was about eight times higher than that of the obstructive pattern. In the early study conducted in gold mines, two-thirds of the workers had lung function impairment, and the restrictive pattern was more prevalent than the obstructive pattern.[2] This result is supported by a previous study conducted among Libyan quarry industry workers, reporting lung function parameters were significantly lower in the exposed group of occupational dust.[18]

The majority of marble stone carvers who use face masks were found to have lung function impairment. In multivariable logistic regression analysis, the workers who do not use face masks were less likely to develop lung function impairment than their counterparts (aOR = 0.11, 95% CI = 0.01-0.91). Likewise, a previous study conducted in gold mines reported similar findings.[2] The reasons for these were only disposable masks or ordinary cloth masks were used among workers instead of appropriate devices like respirators and the disposal of dust-covered disposable masks may act as a source of re-exposure to the workers, which predisposes to the occurrence of lung function impairment. Therefore, the use of appropriate respirators should be encouraged, which can be done by health education, awareness-raising, and appropriate training programs in the workplaces. This suggestion is similar to a study conducted among cement factory workers in the United Arab Emirates, mentioning the workers who use the proper respiratory protection devices (N95 particulate respirator masks) all the time had a lower prevalence rate of respiratory impairment.[15]

There was no statistically significant association between years of employment and lung function impairment, although the proportion of presence of impairment was higher in the group with more serviced years. The comparable results were found in the study conducted among workers in the gold mines[2] and the Libyan quarry industry.[18] However, lung function parameters were significantly decreased with length of employment years in the study among quarry workers of stone crushing industrial site in Nigeria.[1] Some reasons can explain the discrepancy results. The occurrence of lung function impairment may not solely depend on the duration of employment years. This may also be related to factors such as individual susceptibility and amount of exposure or dose of dust entering the body.

In this study, the screening test using spirometry was used to assess the lung function impairment among the workers. It was necessary to use further tests such as chest X-ray to provide a definite diagnosis of the

impairment. It is expected that the results of the study would highlight the respiratory problems and help the workers raise awareness of these problems. It is also expected that the regulatory authorities would make appropriate control and preventive measures to reduce the occupational disease burdens among workers in dusty conditions.

Conclusion

The working environment was found dusty, and a significant proportion of marble stone carvers had lung function impairment. The findings indicated that it is essential to adopt proper dust control measures such as the wet method, spraying water onto the marble stone cutting surface, in stone carving workplaces to reduce emissions and exposure to the workers. Health education programs should prioritize among workers, including sharing information about the occupational hazards and diseases and proper use and maintenance of personal protective equipment. Medical surveillance should be done before the workers are employed and repeated at regular intervals.

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