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VENTILATORY FUNCTIONS IN STONE QUARRY WORKERS OF RAJASTHAN

PRATIBHA GUPTA*, MEENAKSHI CHASWAL AND SUMEDHA SAXENA**

Department of Physiology,
University College of Medical Sciences & GTB Hospital,
Delhi – 110 095

and

**PRIA, 42, Tughlakabad,*
Institutional Area,
New Delhi – 110 062

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Abstract : Ninety two stone quarry workers from nearby villages of Jodhpur town were, assessed for their lung functions which included measurement of Forced vital capacity (FVC), Forced expiratory volume in Ist second (FEV_1), and Peak expiratory flow rate (PEFR). A detailed questionnaire was administered to all the workers, who were divided into group I (cutting the stone) and group II (loading and unloading the stone) depending on the nature of their Job. The presenting complaints included cough with sputum (55%), chest pain (79%), bodyache (31%) and 21% gave the history as suffering from tuberculosis. Comparison of the lung function results between two groups indicated a significant decrement of FEV_1 and PEFR in group II as compared to group I workers. The observed lung functions were also found to be lower on comparison with the normative data from Rajasthan. However, no difference in observed lung function results of smokers and nonsmokers were obtained. Thus the reported lower values of lung functions independent of smoking habits, may be due to occupational stone dust exposure.

Key words : stone quarry, pulmonary function test, quartz, silica

INTRODUCTION

Increased prevalence of respiratory symptoms and airway obstruction in stone quarry workers has raised grave concern about the health effects of dust exposure at quarrying sites. The workers employed in stone quarries are exposed to varying concentrations of silica, the most common form of which is Quartz. The quartz is a typical component of rocks and is present in granite, slate and sandstones. The granite contains 30% of free silica, slate has 40% whereas sandstone is pure silica (1). Earlier studies on stone quarry workers have depicted benign pneumoconioses in the form of radiological changes and obstructive impairment of lung functions (2). It has also

*Corresponding Author

been seen that lung function impairment is related to inhalation of respirable dust to which workers are exposed during their working life (3). Similar pattern of lung dysfunction has also been reported in workers exposed to talc dust (4), tobacco dust (5) and in coal miners (6). Assesment of lung function of these workers may add as one of the screening method along with other clinical evaluations including chest x-rays. Keeping these facts in mind, the present study was attempted to bridge the gap in the existing concepts and understanding of lung functions, respiratory sign and symptoms and prevalent smoking habits amongst stone quarry workers.

METHODS

The present study was carried out on 92 male quarry workers. Out of which 76 were involved in cutting the stone and formed group I and 16 doing the job of loading/unloading the stone constituted group II. In each worker age, height and weight were recorded. A detailed questionnaire was completed on all the workers, providing information about duration of exposure (years), smoking history, monthly income, and clinical symptoms. The lung function study was done using digital portable spirometer and the parameters as FVC, FEV_1, and PEFR were measured. The FEV_1/FVC% was a derived value. All tests were performed in sitting position and the subject was asked to exhale into the spirometer as forcibly as possible after maximum inspiration. Each test was repeated 3 times and the highest reading was taken for calculation.

Statistical analysis : unpaired 't' test was used to show difference of pulmonary parameters between group I and group II workers and also between smokers and nonsmokers. Using multiple regression analysis correlation was also derived between all pulmonary parameters and the factors such as age, height, duration of work (yrs) and smoking habits. The Percentage of various signs and symptoms was also computed.

RESULTS

Table I depicts mean values of age, height, duration of work and monthly income of the two groups of workers. Table II reflects the % of various signs and symptoms along with 21% of workers, giving history of koch's. Inter group comparison of pulmonary parameters shown in Table III reveals statistically higher values of FEV_1 and PEFR in group I as compared to group II workers. In Table IV the comparison between smokers and nonsmokers is shown for all pulmonary parameters. None of the difference is statistically significant. Table V shows correlation coefficients between dependent (FVC, FEV_1, PEFR and FEV_1/FVC%) and independent variables (age, height, duration of work and smoking habits). Age and duration of work were found to have significant negative association with FEV_1 FVC and PEFR respectively.

TABLE I : Depiction of physical characteristics and monthly income of stone quarry workers. (N=92).

Variable	*Group-I N=76*		*Group-II N=16*	
	Mean	*SD*	*Mean*	*SD*
Age (year)	31.91	7.32	48.15	11.58
Height (cm)	167.23	6.44	163.42	6.72
Duration of work (yr)	9.32	6.03	18.44	7.04
Monthly income (Rs)	1313.33	527.95	1220.58	553.13

TABLE II : Representation of signs and symptoms amongst stone quarry workers (N=92).

Symptoms	*Number (%)*	*Group I (N=76) Number (%)*	*Group II (N=16) Number (%)*
Cough with Sputum	49 (55%)	36 (47.36%)	13 (81.25%)
Chest Pain	65 (79%)	53 (69.73%)	12 (75%)
Bodyache	30 (31%)	18 (32.68%)	12 (75%)
H/o Tuberculosis	20 (21%)	11 (14.47%)	9 (56.25%)

TABLE III : Comparison of pulmonary parameters between group I (N=76) and group II (N=16) stone quarry workers.

Parameters significance	*Group I Mean SD*	*Group II Mean SD*	*P value*	
FVC (L)	2.83 2.10	1.77 0.65	0.65	NS
FEV_1 (L)	2.28 1.60	1.33 0.06	0.02*	S
PEFR (L/min)	261.80 136.31	148.68 78.56	0.00*	S
FEV_1/FVC%	81 20	76.26	0.31	NS

TABLE IV : Comparison of pulmonary parameters for smoking habits of stone quarry workers (N=92).

Variable	*Smoker Mean SD*	*Nonsmoker Mean SD*	*P value*	*Significance*
FVC (L)	2.79 2.52	2.51 0.96	0.52	NS
FEV_1 (L)	2.18 1.87	2.06 0.96	0.70	NS
PEFR L/min	240.30 143.36	248 124.45	0.78	NS
FEV_1/FVC%	81.0 18.0	81.0 23.0	0.90	NS

TABLE V : Correlation cofficient of dependent variable (FVC, FEV_1, FEV_1/FVC%, PEFR) and independent variable (age, height, duration of work and smoking habits).

Correlation habits	*Age (yrs)*	*Height (cm)*	*D.O.W (yrs)*	*Smoking*
FVC (L)	−0.0052*	0.0999	−0.1567	−0.1600
FEV_1 (L)	−0.0072*	0.1115	−0.1777	−0.1754
FEV_1/FVC%	.0222	−0.1192	−0.0029	−0.1979
PEFR L/min	−0.0512	0.1462	−0.0091*	−0.1661

No of subjects=92 2 tailed significance *=−0.01 **=−0.001

DISCUSSION

The recognition of relationship between stone dust exposure and development of dyspnea in workers is rooted in antiquity. Workers in stone quarries are constantly exposed to different concentrations of crystalline silica predisposing them to suffer from benign pneumoconioses, silicosis and tuberculosis. The charecteristic pathogenesis begins with inhalation of silica particles and their deposition in alveolar spaces. Particles of diameter <3 um and >0.5 um have the best chance of entering and being retained in the pulmonary acini (5). The key event in the genesis of pulmonary disease is the inter action between silica particle and alveolar macrophages (7). Main factors known to influence the presentation and severity of disease are the concentration of free silica in the workplace, the duration of exposure, the physical charecteristics and innate fibrogenic properties of respirable dust (8). Keeping above possible facts in mind we evaluated the obtained pulmonary functions in stone quarry workers. Results of our study have pointed towards an obstructive pattern of impairment of lung functions of the stone quarry workers. On comparing the two groups of workers for their lung functions, group II workers engaged in loading/unloading showed significantly lower values of FEV_1 & PEFR in contrast to group I involved in cutting of the stone. As the cutting possibly requires hard labour in comparison to the loading and unloading of the stone, shifting of the older and debelitated workers during the course of their employment to the later section of the quarry is perhaps a routine affair. In our study also the workers of group-II, were older (48.15 yrs) and were employed for longer duration (18.44 yrs) in contrast to group-I (31.91 yrs, 9.32 yrs respectively). Therefore older age and more duration of employment of group II workers may perhaps be the reason for observed differences. We have also obtained a significant negative correlation between age and pulmonary parameters such as FEV_1, FVC and that of PEFR with duration of work. These correlations indicate decrease of lung functions dependent on age and total duration of work. Therefore the observed lower results of FEV_1 and PEFR amongst group II workers may be explained by their older age and longer duration of employment. Comparison of our results with normative data (from non working Rajasthani population, matched with age and socio economic status) reflect the decline in all pulmonary parameters of stone quarry workers (9). As lung functions are powerful predictors of morbidity, it has been known that subjects aged 55 to 64 yrs with a reduction in FEV_1 equivalent to two standard deviations or greater had fourfold increase in total mortality during subsequent 20 years and 40 fold increase in deaths from respiratory disease (10). Thus early detection and treatment of respiratory ailments can help in significantly reducing the associated mortality and moribidity. Similar pattern of lung dysfunction of occupational origin has also been demonstrated in workers exposed to cotton dust in textile industry (11). Alakija et al observed in cement factory workers that decrease in FEV_1, PEFR and FVC correlated with duration of service and was neither accounted for by age nor height (12). Presence of obstructive form of results interms of significant decline in FVC and FEV_1, has also been observed in workers exposed to asbestos (13), coal (6), grain and

flour (3), tobacco and talc dust (4, 5) respectively. Regarding the role of smoking in observed impairment of lung functions, we have failed to obtain any significant difference of lung functions in smokers and nonsmokers. Our findings are supported by other studies showing decrement of lung functions in nonsmoking cotton dust exposed textile and grain workers (14, 15). In contrast to the above, other studies have indicated that smoking acts synergistically with pollutants at workplace to produce occupational diseases (16).

Conclusion

Stone quarry workers during the course of their employment are constantly exposed to silica dust and the occurrence of tuberculosis in them is also a well established fact (17, 18, 19). It is quite apparent that the workers develop specific diseases or complain of symptoms mainly as the result of chronic exposure to dusty environment of quarry. Our results of negative correlation of PEFR with duration of work and lower values of PETs in group II workers due to their old age and longer duration of employment supports the existing findings on stone quarry workers. Therefore to conclude the observed obstructive pattern of lung functions in group II workers, needs further attention by measuring the particulate concentration at workplace environment and correlating the values of lung functions, respiratory symptoms and chest X rays in order to derive more dependable results.

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