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Research Article

Pulmonary Function Test in Stone Crusher Plant Workers

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Abstract: Stone crushing in India is a small scale industry where a large number of laborers work. Workers at stone crushing site are exposed to silica dust which leads to pulmonary function deterioration. The objective of this study was to study the pulmonary function test in stone crusher workers. This study was conducted at Stone crusher plant located at Nagaur district (Ajmer region) of Western Rajasthan. Male workers working at site were included in this study, this study was conducted on 100 subjects out of which 50 non-controls and 50 were controls. The pulmonary function was performed in quarry workers and controls. Pulmonary functions were assessed by using computerised spirometer. On statistical analysis of pulmonary function test of controls and non-controls the result showed a highly significant decrease in FVC, FEV1, FEV1/FVC and PEFR parameters. On comparing pulmonary function test between quarry workers and controls it was concluded that due to exposure of silica containing dust it leads to deterioration of pulmonary functions in quarry workers. We recommended that wet working, suitable ventilation and information about preventive measures can be provided as protection to the workers.
Keywords: Pulmonary functions, stone crusher workers, silica, respiratory diseases.

INTRODUCTION

With burgeoning infrastructure sector in India, stone crushing is becoming an important industry. It engaged in producing crushed stone of various sizes as per the requirement of respective construction activities such as Highways, Bridges, Buildings, Construction of Roads, and Canals etc. It is estimated that the stone crushing industry is providing direct employment of around 500,000 people across activities such as mining, crushing plant, transportation of mined stones and crushed products etc. The industry carries greater significance in terms of social importance as it is mostly established in rural and economically backward areas with limited employment opportunities. In such places people are uneducated and unskilled, thus the industry becomes only source of earning [1]

Infrastructure work is going on throughout the country as the same is essential for desired growth set by national and state governments. Due to factors like transportation cost, electricity supply, manpower availability and access to supporting infrastructure, one can find many stone crusher facilities along the periphery of Cities or in the vicinity of major construction projects.

The stone crushing industry has been growing rapidly due to increasing infrastructure activities across country. The industry is unorganized and it is estimated that there are more than 12,000 stone crushing units in India [2]. The stone contains approximately 100% free silica and the stone crushing process release high level of respirable crystalline silica dust in the working environment [3]. The stone crusher workers get exposed to crystalline silica that results in respiratory and non-respiratory health effects. Respiratory ill effect due to inhaled crystalline silica is one of the oldest occupational disease. It was reported by ancient Greek as silicosis and still kills thousands of people every year all over the world. Studies suggested that in developing countries, occupational exposure is a well known phenomenon [4,5] The emission of particulates is quite high from quarries compare to power plants, cement factories, refineries and petrochemical industries [6].

Deposition of dust in the lung is one of the key reasons for occupationally related lung diseases. It is influenced by type of dusts, period of exposure, concentration and the size of the airborne dust in the breathing zone [7].

The stone crusher industry not only adversely affects stone crusher workers but also create health hazard to surrounding population by way of causing respiratory diseases. The dust also reduces growth of vegetation, hampers aesthetic of area and adversely affects visibility.

The present study was therefore designed to evaluate the respiratory effects of occupational exposure to silica dust in stone crusher plant workers.

MATERIAL AND METHODS

This cross-sectional study was conducted at Stone crusher plant located at Nagaur district (Ajmer region) of Western Rajasthan. Male workers working at site were included in this study, this study was conducted on 100 subjects out of which 50 non-controls and 50 were controls.

Workers with clinical abnormalities of vertebral column and thoracic cage, anemia, diabetes mellitus, hypertension, pulmonary tuberculosis, bronchial asthma, emphysema and other respiratory diseases and subjects who had undergone abdominal or chest surgery were excluded from the study.

All the subjects were explained the purpose of study, and also to inform them as to how they can avoid the occurrence of various respiratory diseases by quitting the various risk factors and their consent is taken in this regard.

Pulmonary function tests were assessed by using computerized spirometer. It measured forced expiratory volume in one second (FEV_1), forced vital capacity (FVC), computed ratio between (FEV_1/FVC) and Peak expiratory flow rate (PEFR – lit /sec).

Subjects were asked to breathe in deeply as far as possible with the mouth wide open. Following to it, mouthpiece was placed in the mouth and subject was asked to seal his lips and expire rapidly and forcefully through the mouthpiece.

After preliminary trials, the test was performed three times and the best recording was taken. The readings for forced vital capacity (FVC), Forced expiratory volume in one second (FEV_1), Forced expiratory volume percent (FEV_1/FVC %) and peak expiratory flow rate (PEFR) were noted.

The results were presented as Mean±SD and statistical analysis among the quarry workers and controls was carried out by unpaired t-test.

RESULT

Table no.1 and figure no.1 shows comparison of pulmonary function parameters in quarry workers and controls. All pulmonary function parameters were compared in terms of mean values of FVC, FEV1, FVC/FEV1 and PEFR between cases and controls. On statistical analysis of pulmonary function tests of quarry workers and controls showed a highly significant decrease ($p<0.01$) in all parameters (FVC, FEV1, FEV1/FVC and PEFR)

Table 1: Comparison of pulmonary function test between control and non- control

S.NO:	PARAMETER	Mean ± SD		p-value
		CONTROLS	NON-CONTROLS	
1	FEV_1(L)	2.93±0.72	1.21±1.07	0.0001***
2	FVC(L)	3.40±0.61	1.93±0.65	0.0001***
3	FEV_1/FVC(%)	86.81±6.34	49.30±32.66	0.0001***
4	PEFR(L/S)	7.29±2.28	5.76±1.60	0.0002***

P>0.05 (N.S.)*, P<0.05 (S) , P<0.01 (H.S.)*****

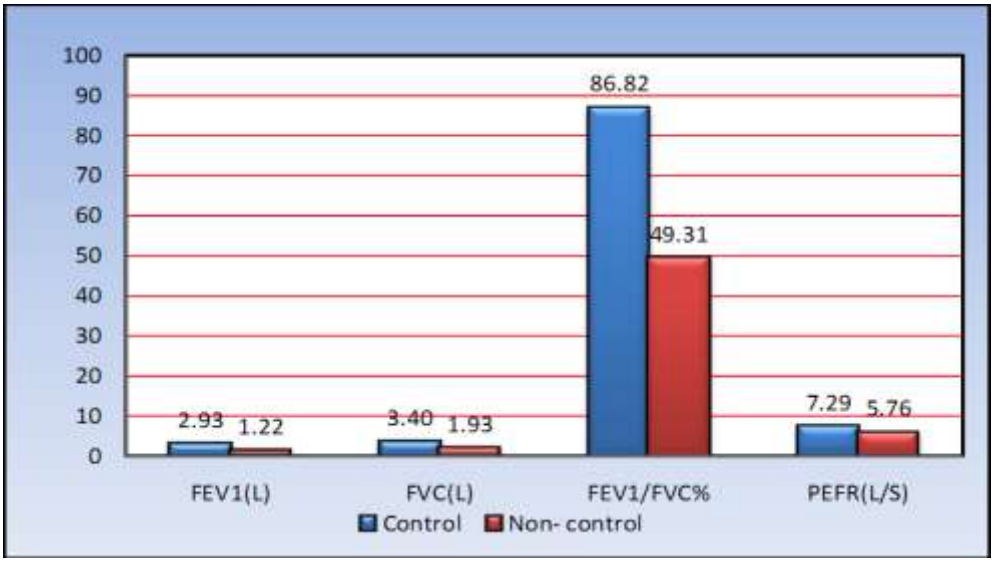

Fig 1: Pulmonary function test between control and non- control

DISCUSSION

Our study was aimed to find the effect of silica dust on pulmonary function tests in stone crusher workers of (Ajmer region) Western Rajasthan. In our study, we observed highly significant ($p<0.01$) decrease in pulmonary function parameters (FVC, FEV1, FEV1/FVC, PEFR) in non-controls (stone crusher workers) as depicted in table no. 1 and figure no. 1.

The parameters FVC, FEV1 and FEV1/FVC provide the best method of detecting the presence and severity of airway obstruction or restriction, as well as the overall respiratory impairment. In our study, FEV1 and FEV1/FVC ratio were also decreased highly significantly and it was more towards obstructive pulmonary impairment. PEFR values which are especially valuable in the diagnosis of obstruction were also reduced in our study. All the above findings suggested the obstructive lung function impairments in stone quarry workers.

As a result of stone crushing process large amount of silica dust is present in atmosphere. The workers working at stone crushing sites are at high risk of developing silicosis. Silicosis is an occupational disease in which irreversible fibrosis occurs so it should be prevented. It also depends on other factors such as duration of exposure; type of silica inhaled and host factors.

Physical form and surface properties of silica also play role in pathogenesis of silica. As crystallized silica such as quartz and cristobalite is more fibrogenic than amorphous silica.

Silica particles when reaches the alveoli are engulfed by macrophages. As silica is cytotoxic so the macrophages which engulfed it are killed. As a result silica dust is released which further activates viable macrophages along with secreation of macrophages derived growth factor such as IL-1 which results in proliferation of fibroblast and collagen synthesis.

The silica dust on inhalation causes irritation of respiratory mucosa and hyper secretion of mucus along with hypertrophy of sub mucosal glands in trachea and bronchi. Neutrophils also release proteases which stimulate hyper secretion of mucus. Also there occur marked increase in goblet cells of small airways producing excessive mucus which further exacerbate the condition and changes in its chemical composition [8] Due to changes in viscosity and elasticity property of mucus, its clearance from airway lumen becomes difficult and thereby results in mucus plug formation [9].This causes obstruction to the airflow leading to decrease in the FVC, FEV1, FEV1/FVC%, PEFR.

Similar to our present study, AN Nwibo *et al.;* also found that the mean ± SD FEV1 and FVC values were significantly decreased among quarry workers of stone crushing industrial site at Umuoghara, Ebonyi state, Nigeria [10].

CH Kiran kumar *et al.;* also found significant reduction in mean values of FVC, FEV1, FVC/FEV1 %, PEF, and FEF25-75% between quarry workers and their matched controls [11].

CONCLUSION

The study concluded that an exposure to dust containing silica in stone crusher workers leads to deterioration of pulmonary functions.

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