Assessment of pulmonary function impairment among mine workers

Shweta Gupta[1], Umesh Dhumne[2], Sarang Dhatrak[3], Subroto Nandi[4,*]

[1]Scientific Assistant, [2]Scientific Officer, [3,4]Assistant Director, Dept. of Occupational Health, National Institute of Miners Health, Ministry of Miners, Govt. of Delhi, Nagpur, Maharashtra

***Corresponding Author:**
Email: snandi76@rediffmail.com

Abstract

Background: Mining provides employment opportunity and infrastructural development with impact on the health of mine workers. Respiratory system is one most affected due to exposure to dust generated during mining operations. The present study was conducted to evaluate the association between the impacts of mining on respiratory functions of workers. The study was conducted to assess the impact of occupation on the spirometric parameters of mine workers.

Methodology: The study was conducted among on 110 subjects, of which 85 belongs to exposed category comprising of mine workers and 35 were control comprising of general population. The information regarding their demographic status, nature of occupational work and exposure, addiction habit was noted. The respiratory function was analyzed by spirometry measurements for Forced Vital Capacity (FVC) and Forced Expiratory Volume in one sec (FEV1) indices.

Results: Study showed significant reduction in overall mean values of spirometric parameters among the workers was more as compared to control population. The co-relation between dust exposure and lung impairment was found to be significant.

Conclusions: From the findings of the present study, we may conclude that there is persistent lung impairment among mine workers due to dust exposure at the workplace. Therefore, the study advocates the importance of awareness about dust exposure to the mine workers.

Keywords: Dust exposure; FVC; FEV1; Mine workers; Spirometry

Introduction

WHO in 2005, reported that the most common occupational morbidities among workers are back pains, hearing loss, lung disorders and injuries [1]. As concerned to the respiratory diseases related to occupational dust exposure, several epidemiological studies have been conducted among workers with regards to morbidity and mortality pattern [2-6]. Also the research studies have been conducted to evaluate the association between the occupational dust exposure and determinants of lung parameters with respiratory symptoms among workers. The most commonly observed respiratory symptoms among workers were phlegm, wheezing, breathlessness, asthma, chronic cough, etc. These studies also depicted spirometric parameters such as Forced Vital Capacity (FVC), Forced expiratory Volume in 1 second (FEV1), FEV1/FVC ratio, Forced expiratory Flow (FEF25-75%). Peak Expiratory Flow Rate (PEFR), Peak Inspiratory Flow Rate (PIFR) and Forced Inspiratory Vital Capacity FIVC were significantly lower in exposed workers [7- 11].

The mine workers are vulnerable group exposed to dust generated during their working hours in mining operations like blasting, crushing, loading, etc. Chest radiographs and spirometry are widely used for determination of pulmonary abnormalities. Spirometry is relatively easier, convenient and cheaper to know the functional capacity and any impairment of the mine workers lungs. The present study was conduct to assess the effect of occupational dust exposure on the respiratory system of mine workers.

Materials & Methods

The study was approved by Institutional Ethics Committee. The study was conducted in the state of Jharkhand with due consent of 110 study subject, which included 35 controls from general population who are not exposed to the mining operations. And 85 workers actively engaged in mining operations. The study subjects belong to age group of 20-60 years with same socio-demographic status. The study objective was explained to study subjects. The study subjects were interviewed to bring out the basic information in a structured predesigned questionnaire to collect the personal information like name, age, sex, height, weight & behavioural habits etc.; current and past occupational history i.e., nature of duty and duration of exposure and all other work; recent and past medical history i.e., respiratory illness or any other surgery. As per the standard recommendation of ATS, the spirometry test was performed by the calibrated portable computerized Spirometer with analysis of major indices i.e., Forced Vital Capacity (FVC), Forced Expiratory Volume in 1 second (FEV1) and the ratio of these values i.e., FEV1/FVC%. The device measures actual respiratory flow in addition to predicted values according to age, sex, height, weight and race. A disposable mouth piece was inserted into the mouth beyond the teeth and asked to blown out as hard and fast as possible into the spirometer after maximal inspiration. The proper technique of spirometry was based on the manual operation of the instrument with special reference to approved standards & provided to each participant

while performing the others blew into the spirometer. The posture of the performing test was in sitting position with the fitted nose clip. After adequate rest, best of three acceptable tracings that met the acceptability and reproducibility criteria was recorded for further research analysis purpose. The participants were advised to avoid smoking or alcohol consumption or inhale bronchodilators prior to the test. The results of the spirometry were interpreted as normal, obstructive, restrictive or mixed impairment. Measured FVC < 80% of predictive value is termed as Restrictive impairment (RI), FEV1/ FVC < 70% is termed as Obstructive Impairment (OI), and combination of RI as well as OI was termed as mixed impairment [12].

Statistical Analysis: The data of pulmonary functions were presented as the mean ± standard deviation for each of the parameters. Statistical analysis between the means of variables in two groups was compared by using independent samples t-test while one way ANNOVA test was applied for multiple comparisons within the groups. Categorical variables were compared by using the chi-square test. The level of statistical significance was set at $p<0.05$.

Results

The general information of the study participants are shown in Table 1. Majority of the study participants were in the age group of 51–60 years i.e. (36.4%) followed by 22-39 years of age group i.e. (33%) while remaining (30.5%) of participants belongs to 40–50 years of age group. As per the distribution of BMI variables, 49.1% of study participants had normal BMI values whereas 45% of study participants were overweight while 6% were underweight.

Table 1: General Information of the study subjects

	Parameters	Control (n=33)	Exposed(n=85)
Age	22-39 (n=39)	20 (60.6%)	19 (22.3%)
	40-50 (n=36)	08 (24.2%)	28 (33.0%)
	51-60 (n=43)	05 (15.1%)	38 (44.7%)
BMI	Underweight (n=07)	05 (15.1%)	02 (2.35%)
	Overweight (n=53)	10 (30.3%)	43 (50.6%)
	Normal (n=58)	18 (54.5%)	40 (47.0%)
Addiction	Smoker (n=28)	08 (24.2%)	20 (23.5%)
	Non-smoker (n=90)	25 (75.7%)	65 (76.5%)
	Drinker (n=42)	13 (39.4%)	29 (34%)
	Non-drinker (n=76)	20 (60.6%)	56 (66%)
	Tobacco. chewer (n=50)	16 (48.5%)	34 (40%)
	Non-chewer (n=68)	17 (51.5%)	51 (60%)

Figures in parentheses indicates percentage

Table 2 shows that by applying the independent t-test the mean values of lung indices such as FVC and FEV1 were statistically significant in between two groups. It is observed that the deterioration of spirometric parameters i.e. FVC, FEV1, FEV1/FVC ratio, PFER and FEF25-75% were higher in exposed workers as compared to the control group.

Table 2: Parameters of Lung Function Tests

Parameters	Controls (33)	Exposed (85)	P-value
FVC (lit)	3.06±0.52	2.85±0.45	0.03*
FEV1 (lit)	2.83±0.56	2.60±0.45	0.02*
FEV1/FVC (%)	92.1±6.47	91.3±6.81	0.56 NS
PEFR (lit/sec)	3.84±1.27	3.54±1.05	0.35 NS
FEF25-75% (lit/sec)	6.35±1.91	6.02±1.68	0.19 NS

*significant, NS- non significant

Table 3 describe the distribution of exposed workers according to their length of services. The mean values of lung indices such as FVC, FEV1, FEV1/FVC ratio, PFER and FEF25-75% were gradually decreases with increasing length of services which shows statistically significant difference among the groups except for PEFR showing non-significantly reduction.

Table 3: Spirometric parameters in relation to length of service

Parameters	≤ 10 years (23)	11-20 years (27)	≥ 20 years (35)	F-value	P-value
FVC (lit)	2.97±0.52	2.93±0.36	2.71±0.43	3.12	0.04*
FEV1 (lit)	2.83±0.49	2.65±0.34	2.41±0.43	7.16	0.001**
FEV1/FVC (%)	95.5±3.90	90.5±7.26	89.1±6.83	7.50	0.001**
PEFR (L/s)	6.31±1.61	6.04±1.71	5.81±1.71	0.61	0.54 NS
FEF25-75 (L/s)	4.18±0.86	3.49±1.00	3.16±1.02	7.67	0.001**

*significant, ** highly significant

Discussion

The present study conducted among 110 workers of which 85 were mine workers actively engaged and getting exposed to dust during their working activity where 35 persons from general population were taken as control group. In current study, overall deterioration of pulmonary function was observed in exposed group as compared to control. All the parameters showed decreased values in exposed group. It was observed that statistically significant lower mean values of FVC%, FEV1% and FEV1/FVC ratio among exposed than controls. Similar results were obtained by Chau and his colleagues wherein they found a relation between a decrease in VC, FEV1 and FEV1/VC in workers who had worked underground for more than 20 years.

In an exploratory study, Singh and his colleagues revealed the spirometric parameters such as FVC, FEV1, FEV1/FVC ratio, FEF25-75%, PEFR, PIFR and FIVC were significantly lower in exposed group than control [11]. In another study, Neghab and his colleagues reported mean values of FEV1 and FEV1/FVC ratio were significantly lower in exposed workers than those of the unexposed workers [13]. Tosho and his colleagues observed the mean values of FVC, FEV1, PEFR, and MVV were significantly reduced in the exposed workers [14]. Similar findings were observed in a other studies. In the present study, it was observed that as the duration of work increases there is statistically significant reduction in all the pulmonary parameters as shown in table no. 3. Similar findings were seen in study done by Abdel-Rasoul and his colleagues which showed as the years of employment increases, the deterioration of spirometric parameters also increases which was significant [15]. Hence it may be concluded that the reduction in spirometric findings may be attributed to workers occupation.

Awareness is required among workers to educate about hazards of dust exposure and measures for its mitigation. Hence it is recommended that importance of personal protective devices like dust mask and other engineering measures be made aware to the workers.

Conflicts of interest: None declared

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