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Pulmonary Function Test of Coal Miners in Damini Colliery, M. P., India

Pragya Dubey and A. N. Sharma

Department of Anthropology, Dr. H. S. Gour Vishwavidylaya Sagar-470003(M.P.), India. Email: pragyadubey810@gmail.com.

KEYWORDS

Coal workers, forced vital capacity, lung function, spirometry test, dust exposure

ABSTRACT

Coal mining is an ancient occupation, long-standing identification as being difficult and responsible due to injuries and disease. Spirometry predicts early damage of pulmonary system and respiratory chronic airway disorders. Exposure of coal dust affects various body systems. The present study focused on coal workers who are constantly exposed to air pollutants such as coal dust. Study was conducted among 400 male coal mine workers. Out of total mine workers, 205 workers were smokers and remaining 195 were non- smokers. Spirometry test revealed 9.75 % of workers were mild (26-30 years of age group), 20% moderate (31-35 and 36-40 years of age group), 6.25 % were moderately severe (41-45 years of age) and 12 % (from 46 years and above) of them was found severe obstruction stage among smoking workers. Non smoking workers were not affected by any types of obstruction, so there was significantly correlation between forced vital capacity and smoking workers. The results suggest that there is a need to improve their health and change their habits because it is more harmful to their health.

Introduction

The objective of coal mining is to extract coal from the ground. Mining is an ancient occupation, long believed to be responsible for injuries and illness. Technological advances nowadays have made coal mining more productive than it has ever been. Modern mining personnel must be trained in the use of highly skilled, well-complex, state-of-the-art equipment to keep up with technology and extract coal as much as possible. Coal mine dust is a mixture containing more than 50 substances (Agarwal, et al. 2015). Coal is a flammable sedimentary rock that is mostly formed 86.2% of carbon and hydrocarbons (Soutar et al. 2004). In mines, we have hardly any choice in deciding the properties of the body of ore or coal, the climate of the surface, the flow of flat water and / or gas, and the physical and chemical properties of the rock. (Wallace, et al. 2015). Coal mine workers face many types of crises that affect their health. The risk of injury is almost constant, with miners often injured by falling objects, equipment and roof collapses. Although the risk of bodily injury is a real concern for many, it is not the only danger that miners face. They also run the risk of respiratory damage through high levels of dust and other chemical particles present in deep coal mining facilities. They are also known as coal workers' pneumoconiosis (CWP) (black lung disease) classified as an industrial disease, which is the result of breathing dust from coal, graphite, or man-made carbon.

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Since the late 1950s, many studies have demonstrated connection among respectable dust exposure development of pneumoconiotic in coal mines diseases. At first, it was considered to be purely the result Exposed to silica present in coal mines, but further Studies indicate that severity was not related Silica content of coal but in total dust Lung (National Institute for Occupational Safety and Health 1995). Dust resides in the body and remains in the lungs where it builds up progressively over time if the person remains in contact for long periods of time as the lungs are unable to expel the dust. This can cause inflammation, fibrosis, and in worst cases necrosis. There are two types of pneumoconiosis of coal workers i.e. simple coal worker's pneumoconiosis (SCWN) and progressive massive fibrosis (PMF) sometimes referred to as complex coal worker pneumoconiosis. Coal pollutants also play a role in the development of chronic obstructive pulmonary disease (COPD), a lung disease characterized by permanent contraction of the airways. Between 2% and 5% exposure to miners Respectable coal dust will have a Category two or greater Coal Workers Pneumoconiosis, Based on their cumulative lifetime risk (Attfield & Moring 1992). Pulmonary function tests are a group of tests that determine how well your lungs are functioning. The tests determine lung volume, flow rate, lung capacity and gas exchange. This includes how capable you are of breathing and how effective your lungs are in taking oxygen to the rest of your body. Pulmonary testing combines with spirometry that measures the amount of breath inside and outside. A spirometry study was carried out to assess the prevalence of pneumoconiosis in miners working in difficult environments of coal mines, with a specific aim to address health and respiratory problems due to coal dust.

Tobacco smoking is the leading cause of premature deaths worldwide. India ranked second in the number of smokers after China, as an estimated 120 million Indian adults smoked here in 2010. Most tobacco smokers in India smoke the bidi, a small cigarette made of tobacco wrapped with a tendu leaf. In 2010 about 1 million people died in India due to smoking, out of which 70 percent in ages of 30-69 years. We examined smoking correlated by age, education level, duration of smoking and workplace environment.

Material and Method

The present study was conducted in Damini Colliery of South Eastern Coal Limited (SECL) which is situated in Sohagpur area approximately 20 kilometers from Burahar block of Shahdol district, MP. All the available workers were covered for the investigation purposively. Designed a semi-structured interview- scheduled for the collection of data of 400 male coal mine workers from different age groups. In the semi structured schedule collected demographical data viz. age, education, duration of mining work, smokers and non smokers, pulmonary function etc. All examination was done according to the Declaration of Helsinki (2013).

Pulmonary function tests

Pulmonary function tests were performed by standard laboratory methods using a spirometer. Spirometric indices help in the diagnosis of both obstructive and restrictive type of ventilatory defects. All these tests were performed on subjects at a comfortable and upright position. During the test, we put a nose clip on the subject's nose and encouraged him to do his best. Trials were repeated three times and the best matching results were considered for investigation. The parameters measured by the instrument were the forced vital capacity (FVC), forced Expiratory Volume in 1st second (FEV_1/FVC). Normal FVC volume for men is 4.8 L. The forced expiratory volume (FEV) is the volume of air exhaled in a given time (usually 1second , referred to as FEV_1).Yet, another important parameter derived from spirometric data is the FEV1/FVC ratio, Normally, it is reached within 3-4 seconds. It

is a useful index for assessing the magnitude of airway obstruction. The results of spirometry test were done on different categories of workers.

The parameters calculated and recorded includes:

- $vFEV_1$ (Forced Expired Volume in 1 Second) measured in Litres, which is total amount of air exhaled in the 1st second.
- vFVC (Forced Vital Capacity) measured in Litres, which is the total amount of air exhaled during the FEV_1 test.
- $vFEV_1$/FVC is the ratio of the two measures (%) and gives an indication of airflow restraint.

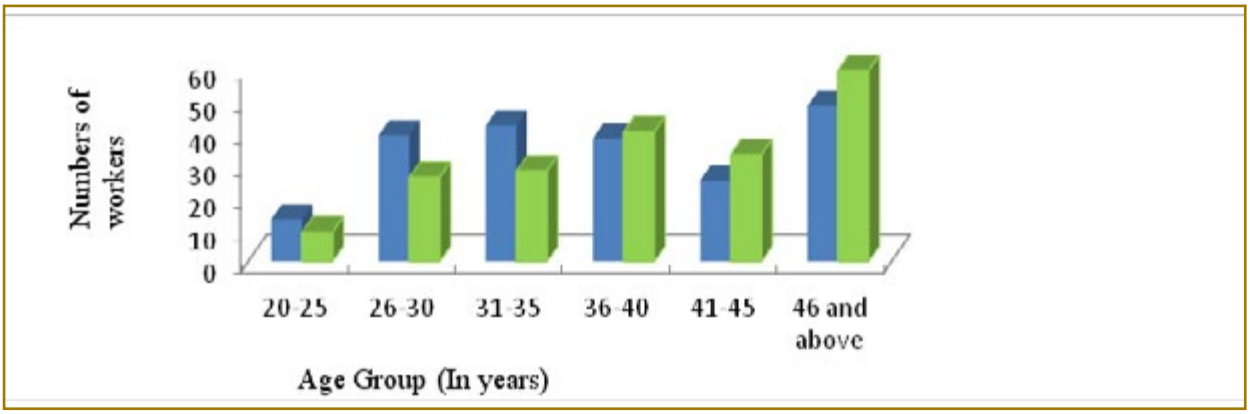
Statistical analysis

The analysis of Mean ± standard deviation for each of the parameter; the two groups were compared and correlated by SPSS software.

Result

In the present investigation out of all workers, 51.25 percent workers were smokers and remaining 48.75 percent were non- smokers. Figure 1 displays the graphical representation of smokers and non smokers according to age group. Figure showing 3.25 percent workers from the age group of 20-25 years were smokers, 9.75 percent workers from the age group of 26-30 years, 10.5 percent from the age group 31-35 years, 9.5 percent from 36-40 years, 6.25 percent from 41-45 years and 12 percent miners from 46 years and above were smokers, similarly 2.25 percent workers were non- smokers from the age group of 20-25 years, 6.5 percent workers from the age group of 26-30 years, 7 percent from the age group 31-35 years, 10 percent from 36-40 years, 8.25 percent from 41-45 years and 14.75 percent miners from 46 years and above were non smokers.

Figure 1: graphical representation of smokers and non smokers according to their age.



The information of pulmonary function tests were showing for each parameter FVC, FEV1 & FEV1/FVC percent in different category of workers were given in Table 1. Before explaining the result of subject workers, one should remember that spirometry tests are only the indications and yet do not necessarily lead to an exact diagnosis; but they correctly define the functional pulmonary abnormalities that are useful for assessing respiratory anomalies.

Commonly used indices, for the purpose of diagnosis are FVC, FEV1 & FEV1/FVC ratio. FEV1/

FVC is a valuable index for estimating the magnitude of airway obstruction. This is so, because timed volumes are reliant on vital capacity and size of body and are therefore variations. As is evident, expressing the amount of timed as the ratio of vital capacity reduces this variability FEV1 in obstructive in FVC in preventive diseases are the excellent parameters for surveillance the progression of these ailments. Spirometric norms are calculated by curves. In general, it is appropriate to record the maximum readings of forced expiratory volume for one second (FEV1), and forced vital capacity (FVC). All the pulmonary parameters shows in Table 2 for different class of workers, a critical examination of these outcome comes to the following observations:

- i) The predicted FEV1 % is commonly usage to grade severity in patients with restrictive, obstructive and mixed pulmonary disadvantage. Pellegrino et al., (2005) given data which can be utilize to rate the level of severity as shown in Table 1.

Table 1: Degree of severity of obstructive airway disease based on the forced expiratory volume in one second (FEV_1). (From ATS/ ERS 1991). Pellegrino et al, 2005, p.957

Degree of severity	FEV_1 % of predicted
Mild	≥ 70
Moderate	60 – 69
Moderately severe	50 – 59
Severe	35 – 49
Very severe	s < 35

** ATS = American Thoracic Society ; ERS = European Respiratory Society*

Table 2: Pulmonary function tests among smoking and non-smoking workers.

Age group of workers (in years)	Workers in different category	FVC (L)	FEV_1 (L)	FEV_1/ FVC (%)	Remarks	*p* Value
		Mean ±SD	Mean ±SD	Mean ±SD		
20-25	Smokers	2.95±0.01	2.26±0.01	76.61±1.02	Normal	0.879
	Non Smokers	2.67±0.01	2.33±0.02	87.50±1.06	Normal	
26-30	Smokers	2.33±0.01	1.65±0.02	70.81±1.08	Mild Obstruction	0.172
	Non Smokers	3.83±0.00	3.35±0.00	87.39±0.95	Normal	
31-35	Smokers	4.01±0.01	2.73±0.00	68.07±0.87	Moderate Obstruction	0.083
	Non Smokers	4.00±0.01	3.50±0.01	87.50±0.08	Normal	
36-40	Smokers	3.83±0.00	2.58±0.01	67.36±1.08	Moderate Obstruction	0.075
	Non Smokers	1.92±0.01	1.67±0.00	86.96±1.13	Normal	
41-45	Smokers	3.67±0.00	2.11±0.03	57.49±1.11	Moderately Severe Obstruction	0.033*
	Non Smokers	1.33±0.01	1.17±0.00	87.50±1.16	Normal	
46 and above	Smokers	4.17±0.00	1.86±0.01	44.60±0.96	Severe Obstruction	0.008*
	Non Smokers	1.83±0.10	1.23±0.02	67.21±1.21	Moderate Obstruction	
Total	Pearson's' correlation between FVC & Smokers/ Non Smokers is 0.046* significant at the 0.05 level (2-tailed).					

- ii) The values of Forced Vital Capacity (FVC) of different categories of workers were observed in the range between 1.33±0.01to 4.01±0.01, which is closer to normal (4.8L for males) value. The deduction in FVC values signifies that there is both restriction and obstruction types of

lungs severity.

- iii) Observed in all pulmonary parameters, the FVC and FEV1 /FVC have been observed significantly declines for the smokers. The reason for this may be that coal dust in combination among SO2, NOX and tobacco smoke, disrupting the air flow to a greater extends in the lungs.
- iv) The FEV1/FVC values in non-smoking workers from the age group of 20-25, 26-30, 31-35, 36-40 and 41-45 found normal (i.e., 86-87%) as compared to workers of age group 46 years and above (non-smokers) having Moderate Obstruction (FEV1/FVC values is near to 67%).
- v) In workers of age group 20-25 years having smoking habit, the FEV1/FVC values were near normal (around 77%).
- vi) Workers of age group 26-30 years and 31-35, 36-40 years having smoking habit, the FEV1/FVC values were found more significantly declining (around 70% to 67%) and were seen Mild Obstruction & Moderate Obstruction
- viii) These results indicate that coal mine workers especially those aged 46 year & above are more likely to be affected by respiratory diseases. Hence, adequate preventive measures to be ensure their safety and prevent health hazards needs to be done.
- vii) The value of FEV1/FVC for workers of age group 46 years and above of age having habit of smoking were found in the category of Severe Obstruction as compared to workers of age group 26-40 years (having Moderate Obstruction).
- ix) Townsend et al., (2011) also elicited the presence of airways obstruction when FEV1/FVC and FVC are below than the lower limit of normal (LLN).
- x) Age group of workers 41-45 years and 46 years and above of age having significantly correlates with declined FVC among smokers and non smokers.

Discussion

The current study stated that long-term exposure to coal dust emphatically less pulmonary function that were exposed to coal dust led to 15 years working experience showed a significant reduction in FVC, FEV1/FVC as compared to non-exposed workers. The causes behind these smokers have a greater chance to developing respiratory problems including the toxic environment of mines. This reduction is also increasing with the age of subjects. It is probable that this reduction of lung function is related to similar factors as exposure to air pollutants like carbon mineral composition may also include traces of elements such as manganese, arsenics, titanium, beryllium, uranium (Sterk et al. 1981). An average cumulative dust exposure, decrease in lung function of miners (Hnizdo et al. 2003). Breathing in coal dust is an important cause of pneumoconiosis in India (Naidoo et al. 2004), and some workers also suffer from silicosis. One of the vital risk factor for chronic obstructive pulmonary disease (COPD) is cigarette smoking. Looking at the published literature of the previous years, 15% of all cases of COPD are working related (Boschetto et al. 2006). Studies of White South African gold miners have shown that the forced expiratory volume in one second (FEV1), and the FEV1/FVC ratio, coordinated with height, age, smoking, tobacco chewing, this decreased along increasing cumulative respirable dust exposure in smokers and non-smokers. The cumulative risk is increasing prevalence of less than 80% forecast. Exposure to coal dust and sulphuric acid also causes miners respiratory disease, which arises from rock waste or deteriorates in piles and when exposed to water and oxygen and also exposure of bed sulphur present in mines (Thomas et al. 2014). The current investigation also observed that 46 years & above of age group has introduce severe obstruction in the lungs. The reason for this is clearly due to the fact that in the underground mining operational environment, the extent of pollutants participated with coal dust is curbed in a limited area, as link-up to open cast environment, where the

pollutants in relatively low concentration spread to the open air.

Conclusion

Numerous epidemiological studies have shown that prolonged exposure to particles adversely affects on health. While so many preventive measures from technological point of view are largely adopted, remedy based on the clinical aspects may be a time-consuming way to control the disease. Findings of the study are summarized below:

- The devastation of lung function was significantly associated with duration of dust exposure, aging and smoking status.
- Reduction in lung function was significantly correlated by increasing age of workers in both smokers and non- smokers.
- Workers not take deep breathing, avoiding prolonged exposure to dust in workplace environment and control breathing with exercise.
- Development of a biometric database of feeble class of workers will help diagnosis of the disease.
- Besides health check-ups at regular interval, strategy to improved heath monitoring workout duration service period and workers age may be further helpful in early diagnosis of disease.

The present study reveals that miners experience significant stressful environment due to dust exposure.

Taking all the points into consideration, it can be concluded that the environment around coal workers needs improvements and they also need to control the smoking habit because exposure to dust and smoking causes more harm to their health.

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