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Physiology

# "A COMPARATIVE STUDY OF PULMONARY FUNCTIONS IN SMOKERS AND NON-SMOKERS"

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**ABSTRACT** Smoking is associated with decline in respiratory functions amongst other hazardous effects on health. The aim of this study was to find out the extent to which pulmonary functions decline in smokers as compared to non-smokers and also between various categories of smokers depending upon their frequency and duration of smoking. 100 smokers and 100 non-smokers who were otherwise apparently healthy, were selected for the study. Pulmonary functions (FVC, $FEV_1$, $FEV_1$/FVC%, PEFR, $FEF_{25-75\%}$ and MVV) were tested in both groups using computerized spirometer. It was found that there was a highly significant decline in all the respiratory functions in smokers as compared to non-smokers ($P < 0.001$). Degrees of decline of pulmonary functions correlated with frequency and duration of smoking as heavy smokers were affected more than moderate and light smokers. Analysis of pulmonary function tests suggested more of an obstructive pattern in smokers.

**KEYWORDS :** Smoking, Pulmonary function tests, COPD

## Introduction

Tobacco smoking is a major cause of death and is estimated to kill around 5 million people around the world every year[1]. This number is predicted to increase in the next 10-15 years and by early 2030, the figures are estimated to double[2]. Smoking is an important risk factor for the development of a number of respiratory diseases which includes COPD and bronchial carcinoma[3].

Pulmonary functions may be severely compromised in tobacco smokers because of the deleterious effect of inhaled tobacco smoke. The present study was undertaken to find out the extent to which lung functions are affected in smokers as compared to non-smokers.

## Method

This was a cross-sectional study conducted in one of the reputed medical colleges in central India. 200 male subjects who volunteered were selected for the study and were divided in 2 groups. The study group consisted of 100 smokers and control group was formed by 100 non-smokers. All the subjects were otherwise apparently healthy and had matching characteristics. Subjects who smoked daily since at least one year were considered as smokers. People who had quit smoking in the past were excluded from the study. The nature of the study was explained to all the subjects and written informed consent was taken. The ethical committee was informed about the study and permission to conduct the study was obtained. Smoking index was calculated for the smokers to evaluate dose and duration response relationship and quantify smoking. Smokers were categorized as heavy smokers, moderate smokers and light smokers on the basis of their Smoking Index[4,5]. Smoking index is calculated by multiplying average number of cigarettes smoked per day and duration of smoking in years.

**Table 1. Categorization of individuals according to Smoking Index[4,5]**

| Smoking Habit | Smoking Index (Frequency x Duration) |
|---|---|
| Non-Smokers | 0 |
| Light Smokers | 1-100 |
| Moderate Smokers | 101-200 |
| Heavy Smokers | More than 200 |

Respiratory parameters ($FEV_1$, FVC, $FEV_1$/FVC%, PEFR, $FEF_{25-75\%}$ and MVV) were recorded using computerized RMS Spirometer-Helios. The subjects were explained the procedures for testing and were given adequate trials before recording the actual readings. Each subject was allowed to make three attempts and the best effort was recorded for analysis. Statistical analysis was done using SPSS-10 software. The descriptive statistics was used i.e. Mean and Standard deviation (SD) for describing parameters. We used Unpaired "t" test to compare the respiratory parameters in both the groups. Unpaired "t" test was also used to compare pulmonary functions between light, moderate and heavy smokers.

## Results

The results of the study are expressed as mean ± SD and depicted in Table. 2-3. P-value lea than 0.05 was considered to be significant. Almost all the pulmonary parameters showed a highly significant decrease in smokers as compared to non-smokers.

**Table 2: Comparison of pulmonary functions in smokers and non-smokers**

| Pulmonary Function test | Smokers (n = 100) | Non-smokers (n = 100) | p- Value | Z –value |
|---|---|---|---|---|
| FVC (L) | 2.75 ± 0.54 | 3.86 ± 0.92 | < 0.001 | 10.41 |
| $FEV_1$ (L) | 2.06 ± 0.48 | 3.21 ± 0.57 | < 0.001 | 15.43 |
| $FEV_1$/FVC % | 74.32 ± 10.47 | 83.43 ± 13.26 | < 0.001 | 5.39 |
| PEFR (L/sec) | 5.20 ± 2.29 | 6.39 ± 2.98 | < 0.01 | 3.17 |
| $FEF_{25-75\%}$ | 2.75 ± 0.21 | 3.46 ± 0.44 | < 0.001 | 14.56 |
| MVV (L/min) | 92.30 ± 34.83 | 120 ± 44.28 | < 0.001 | 5.00 |

**Values expressed as mean ± SD; P < 0.05 significant.**

**Table 3: Comparison of pulmonary functions between light, moderate and heavy smokers**

| Pulmonary Function test | Light smokers (n = 46) | Moderate smokers (n = 34) | Heavy smokers (n = 20) |
|---|---|---|---|
| FVC (L) | 3.12 ± 0.58 | 2.69 ± 0.83 | 2.01 ± 0.44 |
| $FEV_1$ (L) | 2.49 ± 0.47 | 2.03 ± 0.32 | 1.38 ± 0.38 |
| $FEV_1$/FVC | 79.81 ± 12.67 | 76.34 ± 11.34 | 69.29 ± 9.49 |
| PEFR (L/min) | 5.97 ± 2.48 | 5.33 ± 3.59 | 3.56 ± 2.34 |
| $FEF_{25-75\%}$ | 3.12 ± 0.38 | 2.58 ± 0.34 | 2.11 ± 0.48 |
| MVV (L/min) | 108.59 ± 46.38 | 95.39 ± 30.24 | 75.23 ± 33.34 |

**Values expressed as mean ± SD.**

According to values mentioned in Table.2, there was a highly significant difference in all the pulmonary parameters ($p < 0.001$) between heavy smokers and light smokers. Between heavy and moderate smokers, FVC, $FEV_1$ and $FEF_{25-75\%}$ showed highly significant difference ($p < 0.001$) whereas $FEV_1$/FVC%, PEFR and MVV showed significant difference ($p < 0.05$). Differences of $FEV_1$ and $FEF_{25-75\%}$ between light and moderate smokers was highly significant ($p < 0.001$) while FVC was also reduced significantly ($p < 0.05$)

## Discussion

Tobacco smoke as well as their by-products affects the respiratory tract adversely in active as well as passive smokers[6]. Active or passive smoking is associated with higher risks of bronchial asthma, respiratory tract infections and reduced lung functions[7,8,9]. A number of studies have found a positive correlation between smoking and

decreased respiratory functions associated with COPD and chronic respiratory symptoms, such as chronic cough, increased phlegm production, wheezing, and dyspnea[10].

Simmons et al. studied the rate of decline of $FEV_1$ in smokers and found that $FEV_1$ declined substantially in continuing smokers as against sustained quitters. It may also be worthwhile to note that in their study, they found that decrease in frequency of smoking does not significantly decrease the decline in $FEV_1$ as compared to complete quitting of smoking[11]. Orton S et al. and Corbo GM et al. found that even second hand passive smoking in children significantly reduced their $FEV_1$/FVC% as well as forced mid-expiratory flow rate ($FEF_{25\%-75\%}$) indicating a predisposition to COPD and small airways obstruction[12,13].

In our study, we found that all the respiratory parameters were significantly decreased in smokers compared to non-smokers. It was also evident that the frequency and duration of smoking was also a factor determining the degree of deterioration of pulmonary functions. The lung functions decreased more significantly in heavy smokers as compared to moderate smokers followed by light smokers. The trend of decline of respiratory functions in smokers points more towards an obstructive type of lung disease.

Smoking is associated with irritation of the respiratory passages causing more secretions and mucus production. This may be responsible for chronic obstructive changes in the airways which is evident by decreased values of respiratory parameters in smokers. Both $FEV_1$ and FVC are decreased in smokers compared to non-smokers by highly significant statistical margins. A severely declined $FEV_1$/FVC% in smokers is however more indicative of chronic obstructive lung disease and is a good index to quantify the degree of obstruction. Decrease in PEFR indicates involvement of the entire respiratory passage while decline in $FEF_{25\%-75\%}$ is more indicative of small airways obstruction. Decreased MVV in smokers indicates obstructive and restrictive changes in the lungs. However, MVV is not a very reliable indicator because it is subjective to individual effort, co-ordination and co-operation.

## Conclusion

We conclude that smoking causes a significant decline in lung functions as indicated by decreased values of respiratory parameters in smokers as compared to non-smokers. In this study, we also found that frequency and duration of smoking is an important factor which determines the rapidity as well as severity of compromised lung functions. This study would endorse to create awareness regarding harmful effects of smoking on respiratory system and to quit smoking in order to prevent the deterioration of respiratory functions among other hazardous effects of smoking.

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