

# Spirometry in Smokers and Non-smokers: A Comparative Study

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## ABSTRACT

**Introduction:** Spirometry is a physiological test that measures how an individual breathes air volumes as a function of time. Smoking produces an increase in epithelial damage, cellular inflammatory infiltrates, muscles and fibrosis in respiratory airways and is responsible for acute respiratory various illnesses. Early identification of reduction in lung function of smokers by spirometry can be very important in order to encourage them to stop smoking.

**Methods:** This study included a total of 106 individuals, 51 were smokers and 55 were non-smokers. The participants performed spirometry in sitting position by open circuit method. Parameters of spirometry FVC, FEV<sub>1</sub>, FEV<sub>1</sub>/FVC and PEFR were recorded in the form of a percentage of predicted.

**Results:** The mean FVC in smokers and non-smokers was 99.98±9.88% and 102.97±8.03% respectively (p=0.092). The mean FEV<sub>1</sub> in smokers and non-smokers was 99.65±9.61% and 104.58±10.03% respectively (p=0.011). The mean FEV<sub>1</sub>/FVC ratio in smokers and non-smokers was 103.25±4.60% and 105.57±5.10% respectively (p=0.016). The mean PEFR in smokers and non-smokers was 102.11±8.40% and 106.01±10.62% respectively (p=0.038).

The mean FVC in smokers was less than in non-smokers (99.98±9.88% and 102.97±8.03%, p=0.092). FEV<sub>1</sub>, (99.65±9.61% vs 104.58±10.03%, p=0.011) FEV<sub>1</sub>/FVC ratio (103.25±4.60% vs 105.57±5.10%, p=0.016) and PEFR (102.11±8.40% vs 106.01±10.62%, p=0.038) were significantly lesser in smokers than non-smokers.

**Conclusion:** The spirometry parameters of pulmonary function were poorer in the smoker group. Spirometry can be useful in detecting a reduction in pulmonary function before the appearance of any symptoms or before pulmonary functions become significantly abnormal.

**Keywords:** COPD, FEV<sub>1</sub>, FVC, PEFR, pulmonary function test, smoking, spirometry

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## INTRODUCTION

Spirometry is the process of recording volume movement of air into and out of the lungs. It is a physiological test that provides objective and quantifiable measure of lung function. It is an important diagnostic tool as well as a screening test of general respiratory health.<sup>1,2</sup>

Smoking produces various changes in the respiratory airways like increased epithelial damage, increased cellular inflammatory infiltrates, increased muscle and fibrosis. The airways of smokers react to non-specific stimuli by undergoing constriction and produces increase in airway resistance and decrease in forced expiratory volume in one second ( $FEV_1$ ).<sup>3</sup> Causal relationship have been concluded between smoking and acute respiratory illnesses including pneumonia, impaired lung growth, early onset decline in lung function, poor asthma control, chronic obstructive pulmonary disease (COPD), nasal irritation etc.<sup>4</sup>

Chronic obstructive pulmonary disease (COPD) is one of the most frequent chronic respiratory diseases leading to global morbidity and mortality.<sup>5</sup> COPD is an avertible disease characterized by airflow limitation which is not completely reversible. The airflow limitation in COPD is progressive and is associated with an abnormal inflammation of the lungs.<sup>6</sup> COPD is usually identified late, when lung function has already worsened. Cigarette smoking has been identified as the primary risk factor for development of COPD.<sup>7-9</sup>

Early identification of smokers most likely to develop COPD is important in order to encourage them to stop smoking. Spirometric screening of populations at risk for COPD, for example, cigarette smokers, might be a more effective method for early detection of impaired lung function.

A study in our country that studied lung function tests of smoking women found that the lung function test parameters were significantly lesser in smoking women.<sup>10</sup> There is lack of adequate data on spirometry between smokers and non-smokers in Nepalese context. So, this study aims to compare the spirometric parameters between smokers and non-smokers in our

settings.

## MATERIALS AND METHODS

This study was carried out in Clinical Physiology Department of Mahrajgunj Medical Campus in Institute of Medicine, Maharajgunj, Kathmandu from January to November 2011. It included a total of 106 participants, recruited from the out-patient of Department of General Practice & Emergency Medicine. The participants were divided into two groups, smokers and non-smokers. Among them, 51 were smokers and 55 were non-smokers. Ethical approval for the study was obtained from the Institutional Review Board.

The participants of the study performed spirometry in sitting position. MIR Spirolab II spirometer was used for the study. A nose clip was applied to the nose. The participants were instructed to breathe in deep and fast, seal their lips around the mouthpiece tightly and breathe out forcefully and maximally for at least six seconds. The maneuver was done at least three times for each participant at an interval for 3-5 minutes or until the recorded spirograms fulfilled the American Thoracic Society's acceptability and repeatability criteria. Parameters studied were forced vital capacity (FVC), forced expiratory volume in first second ( $FEV_1$ ), ratio of  $FEV_1$  and FVC ( $FEV_1/FVC$ ) and peak expiratory flow rate (PEFR). The best values obtained from the three trials were considered for the study.

Data was analyzed with SPSS software version 16.0. Independent samples t-test was used to compare means between smokers and non-smokers and p-values less than 0.05 were considered statistically significant.

## RESULTS

A total of 106 participants were included in the study. The sample consisted of 75 (70.8%) men and 31 (29.2%) women. Of all the subjects, 51 (48.1%) were smokers and 55 (51.9%) were non-smokers. Of all 51 smokers, 49 (96.1%) were males and 2 (3.9%) were females while among 55 non-smokers, 26 (47.3%) were males and 29 (52.7%) were females. The mean age of the participants was  $28.89 \pm 3.78$  years. The

mean age of males was  $29.19 \pm 3.61$  years and that of females was  $28.15 \pm 4.13$  years.

Table 1 shows the values of spirometry parameters in smokers and non-smokers. All spirometry findings were within normal range in both smoker and non-smoker groups. But, the mean values of all spirometry parameters were higher in non-smoker

group. The mean  $FEV_1$ ,  $FEV_1/FVC$  ratio and PEFR were significantly higher ( $p < 0.05$ ) in non-smokers than smokers. Though mean FVC was also higher in non-smokers, the difference was not found to be statistically significant ( $p = 0.092$ ).

**Table 1:** Comparison of spirometry parameters between smokers and non-smokers

Spirometry Parameters Mean $\pm$ SD	Smokers (n= 51)	Non-smokers (n= 55)	p-value
FVC (% of predicted)	$99.98 \pm 9.88$	$102.97 \pm 8.03$	0.092
$FEV_1$ (%of predicted)	$99.65 \pm 9.61$	$104.58 \pm 10.03$	0.011*
$FEV_1/FVC$ (% of predicted)	$103.25 \pm 4.60$	$105.57 \pm 5.10$	0.016*
PEFR (%of predicted)	$102.11 \pm 8.40$	$106.01 \pm 10.62$	0.038*

\* statistically significant

## DISCUSSION

The objective of this study was to find out whether non-smokers had better pulmonary functions tests than smokers in terms of spirometric parameters. In our study, the spirometry parameters were better in non-smokers than in smokers.

The result of our study is similar to the findings of study by Prasad BK et al that compared lung function tests of smoking women with non-smoking women of 30-40 years in Nepal. The parameters  $FEV_1$ , FEV and PEFR of smoking women were significantly lesser than non-smoking women. These parameters in heavy smoking women were suggestive of chronic obstructive pulmonary disease.<sup>10</sup>

Similar results were found in a study of the ventilatory lung function done in Pamplona city of Spain, which showed that smokers had significantly lower values of parameters FVC ( $p < 0.001$ ),  $FEV_1$  ( $p < 0.001$ ),  $FEV_1/FVC$  ( $p < 0.001$ ),  $FEF_{25-75}$  ( $p < 0.01$  and PEF ( $p < 0.01$ ) than non-smokers. The prevalence of obstructive disorder was also statistically significantly higher ( $p < 0.001$ ) among smokers. Withdrawal of smoking showed a significant improvement of respiratory function parameters after one year.<sup>11</sup>

In a study among 50 smokers and 50 non-smokers aged between 30-60 years that was conducted in Loni of India, the mean values of all the pulmonary function tests parameters FVC,  $FEV_1$ ,  $FEV_1/FVC$ , PEFR,  $FEF_{25-75\%}$  and MVV were found to be significantly reduced in smokers compared to nonsmokers.<sup>12</sup>

In Thailand, a study among male youths of 15-18 years showed that FVC of the non-smoker group was significantly greater than that of the smoker group, while there was no significant difference in  $FEV_1$  between the two groups.<sup>13</sup>

A study in Japan showed that there is only a small difference in  $FEV_1$  between male never smokers and current smokers at younger age but the difference increased with age. Cessation of smoking reduced the rate of  $FEV_1$  decline, in as early as 12 months of stopping smoking. More rapid decline in  $FEV_1$  was observed in current smokers over a 5-year period than non-smokers. These findings suggest that cigarette smoking is associated with reduction in pulmonary function, and that cessation of smoking has a beneficial effect on rate of  $FEV_1$  decline. Smoking cessation program for all smokers, especially for those showing a rapid decline of  $FEV_1$ , should be an important strategy to prevent progression to COPD.<sup>1</sup>

The prevalence of respiratory symptoms has been reported to be higher among smokers and the rate of deterioration of FEV<sub>1</sub> and FEV<sub>1</sub>/FVC is found to be directly associated with the number of cigarettes smoked per day in a study conducted in Spain.<sup>15</sup> FEV<sub>1</sub> decline in continuing smokers was found to be significantly associated with duration of smoking, whereas associations with intensity and pack-years were of borderline significance. Among subjects with impaired pulmonary function, those who quit smoking had significantly slower rates of FEV<sub>1</sub> decline than did those who continued smoking.<sup>16</sup>

Mass spirometry was performed in Poland which showed that in smokers aged more than 40 years and had a smoking history of more than 10 pack-years, airway obstruction was found in 30.6%. Similarly, 8.3% of smokers less than 40 years of age who had a smoking history of less than 10 pack-years had airway obstruction. Mass spirometry could be an effective method in high-risk groups for the early identification of COPD.<sup>17</sup>

## CONCLUSION

Pulmonary function were poorer in smokers than in non-smokers. Reduction in pulmonary function parameters can be detected by spirometry before appearance of any symptoms or before pulmonary functions become abnormal. Screening systems should be developed to ensure systematic identification of cigarette smokers in hospitals and clinics.

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