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Evaluation of Lung Function Test (FEV_1, FVC, FEV_1/FVC ratio, PEFR) among Smokers and Nonsmokers

Dr. Zahid Hasan Khan[1*], Dr. Jesmin Sumaiya[2], Dr. Mukul Chandra Nath[3], Dr. Manik Chandra Nath[4], Dr. Shamima Nazneen Rupa[5], Dr. Sayeeda Sultana Jolly[6]

[1]Assistant Professor (C.C), Head of Department, Dept. of Physiology, Satkhira Medical College, Satkhira, Bangladesh
[2]Junior Consultant, Satkhira Sodor Hospital, Satkhira, Bangladesh
[3]Assistant Professor, Department of Psychiatry, Marine City Medical College & Hospital, Chattogram, Bangladesh
[4]Assistant Professor & Head, Department of Physiology, BGC Trust Medical College, Chattogram, Bangladesh
[5]Assistant Professor (CC), Physiology Department, Rajshahi Medical College, Rajshahi, Bangladesh
[6]Assistant Professor, Department of Physiology, Khulna City Medical College, Khulna, Bangladesh

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***Corresponding author:** Dr. Zahid Hasan Khan
Assistant Professor (C.C), Head of Department, Dept. of Physiology, Satkhira Medical College, Satkhira, Bangladesh

Abstract **Original Research Article**

Background: Cigarette smoking and its health consequences represents one of the most serious public health problems and represents an important health challenge, it carries major health risks with the most cause specific mortalities being those of respiratory and cardiovascular diseases. Tobacco consumption is the most common cause of the preventable deaths globally. Tobacco is often consumed in the form of cigarettes. Deleterious effects of tobacco are seen in all body systems but most markedly on respiratory and cardiovascular systems. Smoking is responsible for 25% of all death in Bangladeshi men aged 25-69 years. Cardiovascular diseases are on the progressive rise in developing countries. ***Objective:*** To measure lung function test (FEV1, FVC, FEV1/FVC ratio, PEFR) among smokers and nonsmokers. ***Method:*** In this study, changes in ECG and pulmonary function tests were evaluated in apparently healthy adult male smokers and nonsmokers. This comparative cross sectional study was carried out in the department of Physiology, Rajshahi Medical College, Rajshahi from January 2018 to December 2018. ***Result:*** A total number of 184 healthy subject aged between 20 to 45 years were divided into two groups – Group A considered of 92 adult male nonsmokers and Group B considered of 92 apparently healthy adult male smokers. Group B are subdivided into light smokers (1-10 stick/day), moderate smokers (11-20 stick/day), and heavy smokers (>20 stick/day). Analysis of data was done with the help of computer by SPSS 12.0 programmer and significant tests were done by unpaired student's "t" test. PFT parameters FVC, FEV_1, PEFR, FEV_1 and FVC ratio were significantly reduced in smokers compared to nonsmokers ($P< 0.001$). The values of FVC, FEV_1, PEFR were significantly reduced with increase number of cigarette smoke per day ($P < 0.001$) while FEV_1/FVC ratio did not show much difference ($P>0.05$). ***Conclusion*:** In this study it was found that the actual values of FVC, FEV1, FEV1/ FVC %, PEFR were decreased in smokers compared to nonsmokers and all the values were more decreased with increase in duration of smoking and increase in number of cigarettes smoked per day.

Keywords: Cigarette smoking, FVC, FEV_1, PEFR, FEV_1/FVC%, ECG, blood pressure, smokers and nonsmokers.

INTRODUCTION

The world Health Organization (WHO) report on the Global Tobacco Epidemic in 2008 highlighted that approximately 5.4 million deaths every year are related to tobacco use, unless urgent attention is taken, more than 80% of tobacco-related deaths will occur in low and middle income countries by 2030 and may kill one billion people during this century (WHO, 2008) [1]. Smoking is the leading known risk factor for the development of chronic obstructive pulmonary disease and 50% of smokers develop clinically significant airflow obstruction [2]. According to the Bangladesh NCD risk factor Survey 2010, the prevalence is 51.0% for any form of tobacco. 26.2% for smoking and 31.7% for smokeless tobacco (SLT) [3]. Current tobacco use is 43.3% in Bangladesh, exclusively smoking is 16.1%, exclusively using SLT 20.3% and dual use of smoking and SLT is 6.8% according to the Global Adult Tobacco Survey [4]. The prevalence of smoking among

men in Bangladesh is higher than The World average of daily smoking among men (37% Vs 31.1%) [5].

According to a proportional mortality study, smoking causes about 25% of all deaths in Bangladeshi men aged between 25 to 69 years and an average loss of 7 yrs of life per smoker [6]. In 1986, NCDs represented only 8% of total deaths compared to 52% of death due to communicable diseases, whereas in 2014, NCDs are estimated to account for 59% of total deaths. CVD is the single-most important contributor, and is responsible for 17% of total mortality [7].

Tobacco smoke contains more than 4000 chemicals and around 40 carcinogens [8]. These include nicotine, carbon monoxide (CO), oxidative gases, polycyclic aromatic hydrocarbons, carbonyls, butadiene, minerals, carbon disulphide and benzene.

Smoking leads to rapid decline in pulmonary function tests specially those indicating diameter of the airways such as forced expiratory flow in first second(FEV_1) [9]. Various authors have used multiple regression analysis to explore the relationship between PEFR and age, height and weight [10]. Smoking has a deleterious effect on pulmonary functions. Accumulation of inflammatory cells such as CD8+ T lymphocytes, B cells, neutrophils and macrophages in response to irritants found in smoke inhalation is responsible for an inflammatory reaction. Hence, the risk of respiratory mortality or morbidity is high with smoking [11].

Nicotine facilitates a conduction block and a reentry and it increases the vulnerability to a Ventricular fibrillation. Nicotine is a potent inhibitor of the Cardiac A type potassium channels which contributes to the changes in the electrophysiology and it also induces arrhythmias [12].

There has been a growing recognition of the importance of the autonomic nervous system in cardiovascular disease various measures of heart rate variability evaluate changes in beat to beat interval durations using ambulatory ECG. Various measures of heart rate variability shortly after smoking cessation. Changes in heart rate and heart rate variability are also described in association with acute passive smoking or exposure to respirable suspended particles [13].

It is well known that the acute effects of smoking produce an increase in systolic and diastolic blood pressure, tachycardia, cardiac output and vasoconstriction, increase in coronary artery occlusion and sometimes instantaneous MI [14].

Smoking cessation does not result in complete reversal of more pronounced airway obstruction but there is significant slowing of decline in lung function in all smokers who give up cigarette. Smoking cessation also substantially reduces the risk of stroke and coronary heart disease and quitting smoking is an important step toward preventing cardiovascular disease [15]. In a community based study showed, Smoking is the risk factor for the development of major abnormal Q/QS wave patterns, T wave abnormalities and development of ST segment depression [16].

OBJECTIVES

General objectives

1. To measure lung function test (FEV_1, FVC, FEV_1/FVC ratio, PEFR) among smokers and nonsmokers.

Specific objectives

1. To compare ECG wave between smokers and nonsmokers.
2. To compare lung function test between smokers and nonsmokers.
3. To find out socio demographic characteristics of smokers and nonsmokers.

METHODOLOGY

Type of study	Cross sectional comparative study
Place of study	Department of Physiology, Rajshahi Medical College, Rajshahi
Study period	January 2018 to December 2018.
Study population	Healthy adult Smokers and non-smokers of 20-45 years in Rajshahi city.
Sampling technique	Purposive

Sample size: A total number of 184 male persons were selected for the study whose ages were between 20 - 45 years. Among them 92 persons were smokers & 92 persons were nonsmokers. BMI matching was considered among smokers & nonsmokers.

Statistical analysis: The significance of difference was calculated by unpaired t-test.

Criteria for subject selection

Inclusion Criteria

1. All individuals should be apparently healthy.
2. Age: 20 – 45 years who are living in Rajshahi city.
3. For cases minimum duration of smoking of 3 years.
4. Participants having no current or past history of smoking are not included.

Exclusion Criteria

1. Females were not included in this study due to cultural reason.
2. Industrial workers.
3. Known case of tuberculosis, chronic obstructive pulmonary disease, asthma, any other cardiopulmonary diseases.
4. Patients with acute respiratory illness, severe systemic illness, chest trauma and dementia were excluded.
5. Known case of ischemic heart disease or other cardiac disease.

Data Collection

The healthy adults who fulfilled the inclusion criteria were enrolled in this study. After taking informed consent complete history taking and physical examination had been done and recorded in a preformed data sheet. Prior to pulmonary function testing, the required maneuver was demonstrated by the operator and subjects were encouraged and supervised throughout the test performance. Pulmonary function testing was performed using the acceptability standards outlined by the American Thoracic Society (ATS) with subjects in a standing position and wearing nose clips in a spirometer.

RESULTS

Table II: Age wise distribution of study subjects (n=184)

Age group (years)	Smokers N (%)	Non-Smokers N (%)	Total N (%)
20-25	8(8.7%)	12(13.0%)	20(10.9%)
26-30	22(23.9%)	18(19.6%)	40(21.7%)
31-35	22(23.9%)	21(22.8%)	43(23.4%)
36-40	30(32.6%)	31(33.7%)	61(33.2%)
41-45	10(10.9%)	10(10.9%)	10(10.9%)
Total	92(100%)	92(100%)	92(100%)

χ^2=1.240, df=4, P=0.872

Table II shows age wise distribution of study subjects. Total study subject participated in this study were 184 and out of them 50% smokers and 50% non-smokers. Among smokers and non-smokers, highest percentage of study subjects were in the age group of 36-40 years. There were no much difference in age distribution between smokers and non-smokers and it was statistically not significant (P value>0.05).

Table III: Distribution of grade of smoking in smokers.

Group	Number of smokers (N)	Percentage (%)
1-10 (light smoker)	52	56.5
11-20 (Moderate smoker)	34	37.0
>20 (Heavy smoker)	6	6.5
Total	92	100.0

Table III shows distribution of grade of smoking in study subjects. Light smokers were commonest (56.5%) followed by moderate (37%) and heavy smokers (6.5%).

Table-IV: Age wise distribution of grade of smoking

Age group (years)	Light smoker No (%)	Moderate smoker No (%)	Heavy smoker No (%)	Total No (%)
20-25	3(9.7%)	5(9.1%)	0(0%)	8(8.7%)
26-30	11(35.5%)	11(20.0%)	0(0%)	22(23.9%)
31-35	8(25.8%)	14(25.5%)	0(0%)	22(23.9%)
36-40	9(29.0%)	21(38.2%)	0(0%)	30(32.6%)
41-45	0(0%)	4(7.3%)	6(100%)	10(10.9%)
Total	31(100%)	55(100%)	6(100%)	92(100%)

χ^2=56.103, df=8, P=0.001

The significance of difference was calculated using Chi-square test.

Table-IV shows age wise distribution of grade of smoking. Most of the smokers were in the age group of 36-40 years (32.6%). Majority of light smokers (35.5%) were in the age group 26-30 years, moderate smokers (38.2%) in 36-40 years and heavy smokers (100%) in 41-45 years.

Table V: Comparison of forced vital capacity (FVC) among smokers and non-smokers (n=184)

Pulmonary function test (FVC)	Smokers (N=92) (Mean±SD)	Non-Smokers (N=92) (Mean±SD)	P-value
Forced vital capacity (FVC)	2.65±0.43	3.83±0.50	0.001(s)

s=significant

Table V shows comparison of forced vital capacity (FVC) among smokers and non-smokers. The mean FVC value of smokers was 2.65±0.43 and non-smokers was 3.83±0.50. The mean forced vital capacity (FVC) level was lower in smokers compared tonon-smokers. This difference was statistically significant (P-value<0.001).

Table-VI: Comparison of Forced expiratory volume in 1st second (FEV_1) among smokers and non-smokers (n=184)

Pulmonary function test	Smokers (n=92) (Mean±SD)	Non-Smokers (n=92) (Mean±SD)	P-value
Forced expiratory volume in 1st second (FEV_1)	2.09±0.37	3.10±0.44	0.001(s)

s=significant.

The test of significance was calculated using unpaired t-test.

Table VI shows comparison of Forced expiratory volume in 1st second (FEV_1) among smokers and non-smokers. The mean FEV_1 value of smokers was 2.09±0.37 and non-smokers was 3.10±0.44. The mean FEV_1 was lower in smokers than non-smokers. This difference was statistically significant which showed lower value of FEV_1 in smokers (P-value<0.001).

Table VII: Comparison of peak expiratory flow rate (PEFR) among smokers and non-smokers (n=184)

Pulmonary function test	Smokers (N=92) (Mean±SD)	Non-Smokers (N=92) (Mean±SD)	P-value
Peak expiratory flow rate (PEFR)	4.30±0.62	5.71±0.43	0.001(s)

s=significant.

The test of significance was calculated using unpaired t-test.

Table VII shows comparison of peak expiratory flow rate (PEFR) among smokers and non-smokers. The mean PEFR value of smokers was 407.17±63.01 and non-smokers was 567.71±48.69. The mean PEFR was significantly lower in smokers than non-smokers (P-value<0.001).

Table VIII: Comparison of FEV_1 and FVC ratio among smokers and non-smokers (n=184)

Pulmonary function test	Smokers (N=92) (Mean±SD)	Non-Smokers (N=92) (Mean±SD)	P-value
FEV_1 and FVC ratio	78.36±2.02	81.03±1.64	0.001(s)

s=significant.

The test of significance was calculated using unpaired t-test.

Table VIII shows comparison of forced expiratory volume in 1st second and forced vital capacity ratio (FEV_1/FVC%) among smokers and non-smokers. The mean FEV_1/FVC% value of smokers was 78.36±2.02 and non-smokers was 81.03±1.64. The mean FEV_1/FVC% level was lower in smokers compared to non-smokers. This difference was statistically significant (P-value<0.001).

DISCUSSION

All the pulmonary function tests like forced vital capacity (FVC), forced expiratory volume in 1st second (FEV_1), peak expiratory flow rate (PEFR), $FEV_1$and FVC ratio are significantly reduced in smokers compared to nonsmokers. The mean Forced vital capacity in smokers were lower when compared to nonsmokers, which was statistically significant (p<0.001). The mean Forced expiratory volume in 1st second were lower in smokers when compared to nonsmokers, which was statistically significant (P<0.001). The mean Peak expiratory flow rate were lower in smokers when compared to nonsmokers, which was statistically significant (P<0.001). The mean FEV_1 and FVC ratio were lower in smokers when compared to nonsmokers.

Several studies have shown an association between cigarette smoking and pulmonary function tests and altered electrocardiogram, but many of these

have lacked enough statistical power to establish a firm association.

This observation was compatible with that of Abbas A H, (2018) and Shukla *et al*., (2002) revealed that smokers have lower BMI than non-smokers [17]. In addition, the study showed significant difference between both groups regarding BMI. Smoking caused decrease in weight which most likely due to loss of appetite in smokers.

In this study, mean (±SD) forced vital capacity was lower in smokers (2.65±0.43) in comparison to nonsmokers (3.83±0.50) which was statistically significant.

This observation was compatible with that of Sivagangailakshmi V and Rajkumar D, (2017) which revealed lower forced vital capacity in smokers (2.34±1.56) than nonsmokers (3.67±0.33) which was statistically significant [18].

On the contrary, Kumar R *et al*., (2017) and Helal O F, (2014) found no significant difference among smokers and nonsmokers [19].

In this study, mean (±SD) Forced expiratory volume in 1st second was lower in smokers (2.09±0.37) in comparison to nonsmokers (3.10±0.44) which was statistically significant.

Similar results were obtained from the study of Malathi R M *et al*., (2017) where mean forced expiratory volume in 1st second in smokers (2.46) was significantly lower than nonsmokers (2.97) [20].

This result was consistent with the results of Patil S S *et al*., (2018) and Shreen L A *et al*., (2017), where forced expiratory volume in 1st second were found significantly lower in smokers as compared to nonsmokers [21].

In this study, mean (±SD) peak expiratory flow rate was lower in smokers (4.30±0.62) in comparison to nonsmokers (5.71±0.43) which was statistically significant.

This observation was compatible with that of the study which revealed lower forced vital capacity in smokers (3.45±0.37) than nonsmokers (5.47±0.40) which was statistically significant.

Similar results were obtained from the study of Mistry A *et al*., (2014) and Nawafleh H A *et al*., (2012), where mean peak expiratory flow rate of study group is significantly lower than control group [22].

In this study, mean (±SD) FEV_1 and FVC ratio peak was lower in smokers (78.36±2.02) in comparison to nonsmokers (81.03±1.64) which was statistically significant.

This result was consistent with the results of Kumar A *et al*., (2013) whereFEV_1 and FVC ratio was found lower in smokers (90.5±4.5) in comparison to nonsmokers (92.6±5.5) which was statistically significant. This result was inconsistent with the result of Vyas H P, (2014). In the study, the results showed (P-value>0.05) which were not statistically significant in both groups.

CONCLUSION

In conclusion we can say that pulmonary function test and electrocardiography are an effective and easy method for detection of pulmonary and cardiovascular diseases in risk group population like smokers and thus promotes smoking cessation efforts to reduce the burden of non-communicable diseases in the community.

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