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Original Research Article

Pulmonary function changes in asymptomatic smokers - a community survey in Udupi, Karnataka, India

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ABSTRACT

Background: Smoking has been labeled the most important preventable cause of a respiratory disease and its effects in a smoker are well established. A better understanding on the pulmonary function impairments in an asymptomatic smoker is the need of the hour. Objective: To study the pulmonary function changes in asymptomatic smokers and non- smokers and to establish the dose -effect relationship amongst asymptomatic smokers.
Methods: A cross sectional survey was conducted in Udupi district of Karnataka, India. 140 men aged between 20 to 45 years with a BMI ranging from 18.5 to 29.9 Kg^2 /m was enrolled in to the study. 70 subjects were asymptomatic smokers and the other 70 were non-smokers. Outcomes measured were standard spirometric measures for pulmonary function and symptoms like breathlessness, cough and sputum using a Breathlessness Cough Sputum scale.
Results: The mean age (mean ± SD) of non-smokers and asymptomatic smokers enrolled was 34.7±5 and 33.8±5 years respectively. The mean smoking dose amongst the asymptomatic smokers was 15.74±5.5 pack years. FEV1 amongst the asymptomatic smokers showed a negative correlation with smoking dose ($p<0.05$) and there was a significant difference in FEV1, FVC, PEFR, MVV and FEF 25- 75 % ($p<0.001$) amongst the asymptomatic smokers and non-smokers.
Conclusions: Asymptomatic smokers showed low values of pulmonary function parameters compared to those in non-smokers.

Keywords: Asymptomatic smokers, Correlation, Pulmonary function

INTRODUCTION

Smoking has been labeled the most important preventable cause of death and disease. Once smoking has caused a disease, the disease is largely irreversible and progressive.[1] Globally, approximately 1.3 billion people currently smoke cigarettes or other products.[2] Although cigarette consumption is leveling off and even decreasing in some countries, in India, the smoking population is still on rise and has been reported to be 26%.[3] As per an estimate drawn by World Health Organization, there are around 94 million smokers in India and amongst them 14 million are suffering from COPD.[4] As per the prediction of a study, the number of men dying from smoking related illness in India could be doubled to more than a million per year by the year 2025.[5] Prevalence of COPD and its association with smoking has been reported to be 4.1% with the smoker: non-smoker ratio to be 2.65:1.[6]

Prevalence of respiratory related diseases is more common in Southern part of India, and Karnataka scores the highest prevalence of respiratory related disease as

per a survey conducted.[4] Smoking is one of the commonest habits amongst men in urban and rural areas leading to respiratory symptoms and deterioration of pulmonary functions. Many risk factors like low socioeconomic status, occupational and environmental factors precipitate respiratory dysfunctions alongside smoking.[7]

The earliest changes, that may occur due to tobacco smoking result in pulmonary airway diseases leading to induction of chronic air–flow obstruction leading to various dose dependent respiratory diseases. The number of packs smoked per day has a significant deteriorating effect on pulmonary functions which in India is difficult to estimate due to the variability in the cumulative dosage of smoking i.e. cigarettes and beedi. Effect of each smoking dose has its unique pulmonary function change, which is yet to be studied.[5]

Cigarette smoking is found to induce lower values of spirometry and forced expiratory values which enhance the development of respiratory symptoms in adults. Irreversible lung function pathology has already been found to have set in the smokers who come with the diagnosis of respiratory related diseases.[6]

Various tests like frequency dependence of compliance, closing volume and pulmonary function test are available for screening the airway obstruction. Nevertheless, pulmonary function test (PFT) values like FEF 25-75%, FEV1, FVC, PEFR and MVV has high coefficient of variation.[5] Thus, there is an urgency to reach a better understanding of relationship of smoking and impaired pulmonary function to disease in order to undertake preventive strategies. There is a dearth of literature on the pulmonary function changes in asymptomatic smokers in India. Hence a survey to correlate smoking dose with PFT values in asymptomatic smokers and compare the same with non- smokers.

METHODS

A cross sectional survey was conducted in Udupi district of Karnataka state, India where young men inclusive of both smokers and non-smokers were screened on convenience. The sample required for the survey was estimated based on the previous literature with the power of the study at 80% and level of significance set at 0.05. A total of 140 subjects were considered adequate to establish the correlation between the doses of smoking to the changes in the pulmonary parameters. Sample was divided into two equal groups based on their smoking habits. Those who are non-smokers are categorized under group 1 and those who were smokers into group 2.

Asymptomatic smokers and healthy non-smokers of same age group (20-45 years) were included in the survey and those with acute pulmonary pathology having cough, sputum, breathlessness, subjects who are contraindicated for pulmonary function testing, chronic infections like TB and with a past history of accidents or surgery involving lungs or ribcage were exempted from participation. Subjects who were graded to have less than or equal to grade 1 cough {How was your cough today? 0 _ none: unaware of coughing 1 _ Rare: cough now and then 2 _ Occasional: less than hourly 3 _ Frequent: one or more times an hour 4 _ Almost constant: never free of cough or need to cough} and breathlessness – {How much difficulty did you have breathing today? - 0 _ None: unaware of any difficulty, 1 _ Mild: noticeable during strenuous activity (e.g., running), 2 _ Moderate: noticeable during light activity (e.g., bed making),3 _ Marked: noticeable when washing or dressing 4 _ Severe: almost constant, present even when resting} and grade 2 sputum { How much trouble was your sputum today? 0 _ None: unaware of any difficulty 1 _ Mild: rarely caused problem 2 _ Moderate: noticeable as a problem 3 _ Marked: caused a great deal of inconvenience 4 _ Severe: an almost constant problem,} on Breathlessness Cough Sputum scale (Chest 2003) were identified as asymptomatic smokers in this survey.

Smoking dose was estimated using pack years and the pulmonary function testing was performed using a Schiller. Inc UK standardized Spirometer.

Procedure

Subjects who meet the inclusion criteria were selected and enrolled into the survey after attaining a written informed consent. Subjects who have smoking history of less than 10 cigarette packs year, 11-15 cigarette packs year, 16-19 cigarette packs year and more than 20 cigarette pack years were divided under groups A, B, C and D respectively.

Pulmonary function testing (PFT) was done as per the guidelines of American Thoracic Society and the participants performed PFT in seated position after a through calibration of spirometer. Three trials of testing were performed and the best of the trials was considered for analysis. Acceptability criteria were start of the test (extrapolated volume of <5% of FVC or 0.15 L, whichever is greater), minimum FVC exhalation time of 6 seconds or reasonable duration of plateau on time-volume curve, free of artifacts like coughing, glottis closure during exhalation, leak, obstructed mouth piece or early termination and end of test criteria. Measures like FEV1, FVC, FEV1/FVC, PEFR, MVV and FEF25-75% were measured from all the subjects.

Data analysis

All the PFT parameters and baseline variables were reported using descriptive statistics (Mean ± SD). Pearson correlation was done to correlate the dose of smoking with PFT parameters along with regression analysis to establish the regression equations. Between groups comparison of smokers Vs non-smokers was done using an independent sample‘t’ test.

RESULTS

A total of 150 subjects were screened of which 140 subjects agreed to participate in the survey. Seventy subjects were non-smokers and the rest were asymptomatic smokers. All the subjects were aged between 20 to 45 years with the mean age (Mean ± SD) of the non-smokers and asymptomatic smokers being 34.7±5 and 33.8±5 years respectively. BMI of the subjects ranged from 18.5 to 29.9 Kg^2/m with the mean in groups 1 and 2 being 24.1 and 23.9 Kg^2/m respectively.

Descriptive details (Mean ± SD) of the PFT parameters of both groups are as shown in Table 1. The mean smoking dose amongst the asymptomatic smokers enrolled in the survey was 15.74±5.5 pack years. Based on the smoking dose, the subjects have been categorized into four subsets for analysis. Subjects smoking <10 cigarette packs year is group A, 11-15 is group B, 16-19 is group c and >20 cigarette pack years is group D. Descriptive statistics (Mean ± SD) of the pulmonary parameters in the four subgroups based on the smoking doses are listed in Table 2.

Table 1: Descriptive statistics of the pulmonary parameters in both the groups.

Group/ PFT parameter	FEV1 Mean ± SD	FVC Mean ± SD	PEFR Mean ± SD	FEF25-75 Mean ± SD	FEV1/FVC Mean ± SD	MVV Mean ± SD
Group 1 Non-smokers	83.4±5.3	85.9±4.5	85.9±4.5	83.6±11	96.9±3.0	83.5±4.0
Group 2 Asymptomatic Smokers	74.8±5.9	76.6±6.1	73.6±6.3	69.4±3.7	98.3±4.0	72.7±5.6

Table 2: Descriptive statistics of the pulmonary parameters in the four subgroups based on smoking dose.

Group/ PFT parameter	FEV1 Mean ± SD	FVC Mean ± SD	PEFR Mean ± SD	FEF25-75 Mean ± SD	FEV1/FVC Mean ± SD	MVV Mean ± SD
Subgroup A (n=15)	81.2±4.8	81.1±5.7	81.2±5.0	71.8±3.3	99.2±3.7	79.4±4.5
Subgroup B (n=19)	75.7±5.0	78.3±6.1	74.0±4.7	70.2±3.5	95.0±2.9	72.5±4.8
Subgroup C (n=18)	73.7±4.1	75.5±5.0	72.3±4.5	69.0±2.9	96.0±3.7	69.9±4.5
Subgroup D (n=18)	69.7±3.5	72.1±4.0	68.1±3.4	67.1±3.6	95.5±4.5	70.0±3.2

Table 3: Regression analyses of smoking dose and PFT parameters.

Parameter		Unstandardized coefficient	Standardized coefficient	Sig
FEV1	**Constant**	106.79		
	age	-0.540	-0.584	0.000*
	dose	-0.289	-0.301	0.002**
PEFR	**Constant**	96.94		
	age	- 0.262	-0.373	0.001*
	dose	-0.260	-0.355	0.001*
FEF25-75%	**Constant**	100.03		
	age	-0.368	-0.414	0.000*
	dose	-0.489	-0.531	0.000*
MVV	**Constant**	98.96		
	age	-0.303	-0.424	0.000*
	dose	-0.309	-0.416	0.000*

*p<0.001, **p>0.001 but <0.05

Authors found a negative correlation between the smoking doses and the pulmonary function parameters. Pearson's r value for FEV1 was 0.281 (p <0.05), FEF25-75% was -0.517 (p<0.001), MVV was -0.405 (p<0.001) and PEFR was -0.361 (p<0.001). Correlation of smoking dose with FEV1, FVC, PEFR, FEF 25- 75% and MVV are as shown in graphs 1 - 5 respectively. Figure 1, 3, 4 & 5 show a negative sloping of the best fit line whereas

graph 2 shows no significant sloping. Data pertaining to the smoking dose and pulmonary function collected during the survey was run through regression analyses to derive the coefficients for the regression equations. Table 3 shows the constants for each parameter and the coefficients for age and smoking dose which could be used in the respective regression equations to compute the impact on the pulmonary parameter.

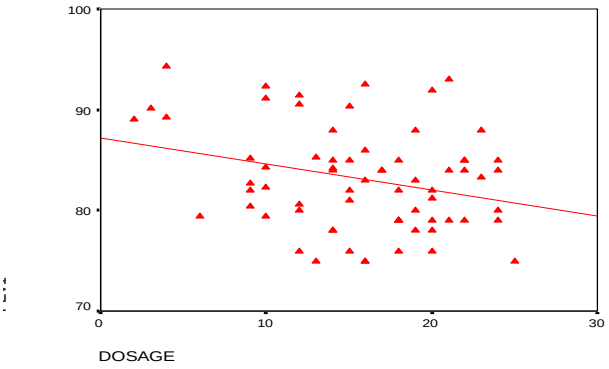

Figure 1: Correlation between FEV1 versus smoking dosage.

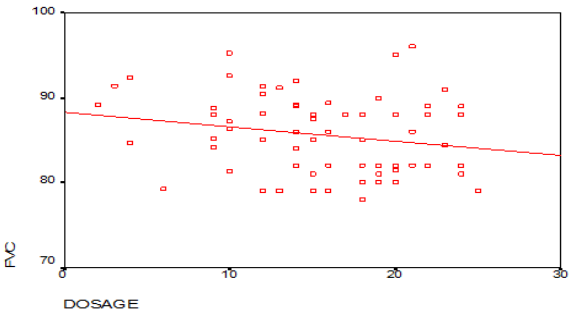

Figure 2: Correlation between FVC versus smoking dosage.

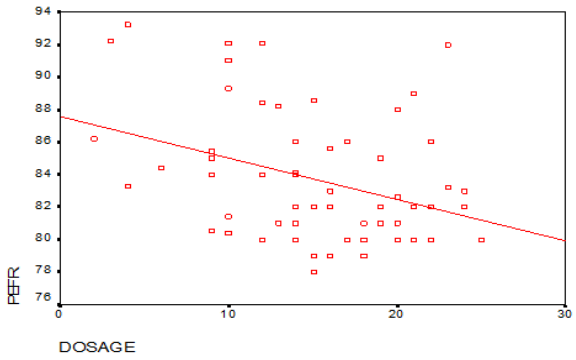

Figure 3: Correlations between PEFR versus smoking dosage.

Based on the constants and coefficients derived, regression equations for pulmonary parameters like FEV1, PEFR, FEF 25-75% and MVV have been established. These equations can be used to compute the dose-effect relationship in asymptomatic smokers based on their age and the smoking dose.

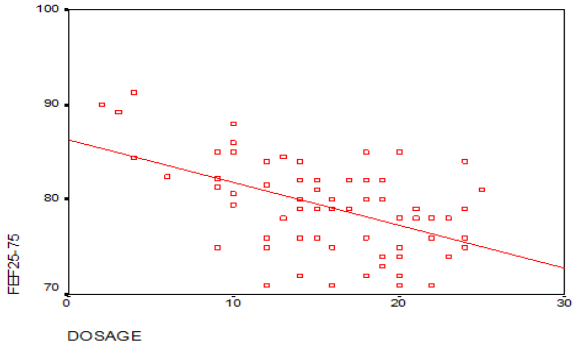

Figure 4: Correlation between FEF 25- 75% versus smoking dosage.

Table 4: Between group comparisons of pulmonary function parameters.

Pulmonary parameters	Non-smokers (Mean ± SD)	Asymptomatic smokers (Mean ± SD)	T-value
FEV1	83.4±5.3	74.8±5.9	7.374*
FVC	85.9±4.5	76.6±6.1	7.072*
PEFR	85.9±4.5	73.6±6.3	7.959*
FEF25-75%	83.6±11	69.4±3.7	3.232**
MVV	83.5±4.0	72.7±5.6	8.539*
FEV1/FVC	96.9±3.0	98.3±4.0	0.771

*p<0.001, **p>0.001 but <0.05

The following are the equations developed: FeV1 = 106.79 – 0.540 (age) – 0.289 (dose), PEFR = 96.94 – 0.262 (age) – 0.260 (dose), FEF25-75% = 100.03 – 0.368 (age) – 0.489 (dose) and MVV = 98.96 – 0.303 (age) – 0.309 (dose). Between groups comparison to understand the pulmonary function in asymptomatic smokers to that in non-smokers using students t test (Table 4) revealed that there is a significant difference in all the pulmonary parameters (FEV1, FVC, PEFR, MVV and FEF 25- 75%; p <0.05) except the FEV1/FVC ratio (p>0.05).

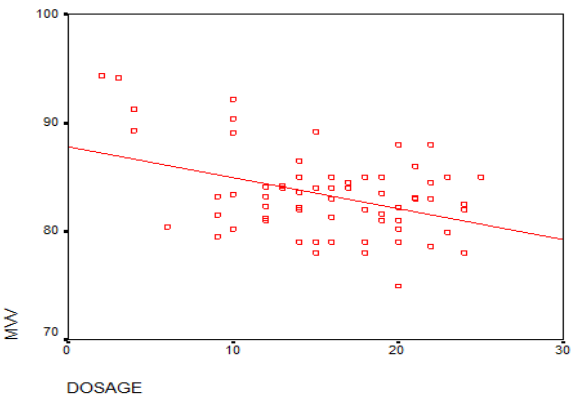

Figure 5: Correlation between MVV versus smoking dosage.

The data presented in the study indicate, that there were significant differences in the pulmonary parameters between smokers and non-smokers and the changes were dose related i.e. to smoking. Moreover, for most of the parameters, changes were greater in heavy smokers than moderate smokers.

DISCUSSION

The current study showed that FEV1 amongst the asymptomatic smokers showed a negative correlation with smoking dose ($p < 0.05$) and there was a significant difference in pulmonary parameters like FEV1, FVC, PEFR, MVV and FEF 25-75% ($p < 0.001$) amongst the asymptomatic smokers and non-smokers.

Current evidence available suggests that early changes in smokers are probably due to narrowing of the small airways. FEF 25-75% incorporates flows over lower lung volumes than does FEV1 and is more likely to be abnormal in patients with small airway obstruction.[15] Another inference that could be drawn was that FEF25-75% would appear to have its greatest utility in the diagnosis and monitoring of early and moderate disease and has less value in following the case of severe disease. The present study showed significant negative correlation in FEF25-75%, MVV, PEFR ($p<0.01$) and FEV1 ($p <0.05$) with reference to previous study.[16] This could be attributed to the higher smoking dose (15.7 pack year) noted in this study in comparison to that reported in the previous study (8.6 packs year).[18]

Present study indicates that the pulmonary function does not significantly decrease in the early stages of smoking, although with continued smoking the value decreases considerably as age progresses. The significant reduction in MVV showed amongst the cigarette smokers in this study was possibly due to reduction of respiratory muscle strength. In a previously published study, long-term smoking drastically reduced expiratory muscle strength and slightly increased inspiratory muscle strength; in contrast, inspiratory muscle endurance, was reduced in the smokers.[15,17,18] In present study we could find a considerable pulmonary function changes in the young heavy smokers, which is consistent with previous studies.[18] Walter et al showed significant changes in lung function in young smokers which was concurred by Seey et al and LIM who also observed similar results in teenagers with smoking histories of 1 to 2 years. Thus, changes in lung function appear to occur early after starting to smoke. Similar to present findings of lower values of FEV1 and other parameters in middle-aged smokers, Hedrick KL et al obtained significantly lower values of FEV1, expiratory flow rates and MVV in middle-aged smokers than their non-smoking counterparts. Current study compared asymptomatic smokers and non-smokers who are comparable on their physical characteristics, physical activity levels, socio-economic status, and environmental conditions. Despite the subjects were of the same race and ethnic origin, there were some marked differences in the results between the two groups. Usually, lung capacities, volumes, and ventilatory flow rates have shown significant differences between smokers and nonsmokers; lower values are obtained in the former group.

The findings of an increasing difference between smokers and non-smokers with increasing age in the spirometric measures in present study possibly reflects the chronic effects of smoking which develop over time in response to repeated insults to the lung. It is possible that the observed changes in pulmonary function with increasing age among smokers could have merely reflected the result of an increase in cigarette consumption, both in terms of pack years and number of cigarettes smoked per day, with increasing age. Significant negative correlations of these smoking variables with pulmonary functions also suggest this hypothesis. It may be that these effects are related to the gradual development of parenchymal destruction and increased compliance, development of bronchoconstriction, inflammation, or mucus production. Results of this study also reveal that the ratio FEV1/FVC% of smokers was significantly higher ($p<0.05$) than that in non-smokers which could be attributed to a restrictive effect due to the reduction in total lung capacity when compared to non-smokers. Our findings are consistent with those reported in the previous study.[18]

Limitations

Few of the subjects enrolled into the study were combined beedi &cigarette smokers and we did not consider the living and occupational environments of the subjects for the survey and analysis. Their influence on the findings could not be ignored.

Recommendations

Future studies considering factors like socioeconomic status, living and occupation environments of the subjects along with a discretion on the type and mode of tobacco

intake (beedi, cigarette & combined) for said doses are recommended to derive better understanding.

CONCLUSION

Asymptomatic smokers showed low values of pulmonary function parameters compared to those in non-smokers and the changes were considerable in young heavy smokers.

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Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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