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Comparison of Spirometry Findings among Smokers and Non Smokers

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Abstract: Smoking remains the leading cause of preventable premature morbidity and mortality in both developed and developing countries around the world. Cigarette smoking directly affects lungs whose normal functioning is essential for our survival. It is responsible for 90% of chronic obstructive pulmonary diseases, chronic bronchitis, and emphysema and lung cancer. This study is undertaken to highlight the effect of smoking on lung functions of smokers and thereby lead them in abstaining from smoking. To compare the lung functions of asymptomatic smokers with that of non-smokers. A total 300 healthy adult male subjects (150 non-smokers and 150smokers) of age group 20-60 years were taken. FVC manoeuvres were recorded by spirowin2 spirometer. Parameters such as Forced Vital Capacity, Forced expiratory volume in 1st second, the ratio of FEV1/FVC, FEF 25-75% and Peak Expiratory Flow Rate were assessed and analysed using the students 't'-test and ANOVA (Analysis Of Variance) for multiple groups. Smoking had an negative impact on lung functions when compared to non-smokers and smokers showed a significantly greater percentage decline in FVC, FEV1, Ratio of FEV1/FVC, FEF25-75% and PEFR. Our results suggest that smokers within few years of starting to smoke developed changes in pulmonary functions indicating early peripheral airway narrowing and that these effects worsen progressively with continued smoking.
Keywords: Smoking; lung functions; spirometry

INTRODUCTION

Cigarette smoking remains the leading cause of preventable premature morbidity and mortality in many countries around the world [1]. Smokers account for one third of world's population (47% of adult men population and 7% of adult women population). Tobacco is responsible for 4 -5 million deaths a year or about 10,000 deaths each day. It is predicted that in next 20 years, the yearly death rate from tobacco use will be more than 10 million people [2].

Because of the long delay between the cause and full effect, people are unable to know the hazards of tobacco. About half of those killed by tobacco were still in middle age (35-55yrs) and thereby, they have lost twenty five years of non-smoker life expectancy [3]. Tobacco use is socially accepted in many segments of Indian society. Tobacco use in Indian society is increasing, but there are considerable changes in the type and methods by which it is used. According to WHO estimation, 194 million men and 45 million women use tobacco in smoke or smokeless form in India [4].

Chronic Obstructive Pulmonary Disease (COPD) is one of the leading causes of morbidity and mortality worldwide and is increasing in prevalence. The diagnosis of COPD at an early stage of the disease may be done by performing spirometric tests in smokers using case finding or population screening method. It can be said that diagnosis of smoking related lung diseases would increase the efficacy of smoking cessation advice in affected subjects [5].

Quitting smoking results in tremendous benefits, in that it reduces lung cancer as well as cardiovascular disease risk and it slows the progression of COPD.1 It is a known fact that incidence of smoking related diseases is greater in younger than in older smokers and also that cessation of smoking reduces risk of diseases caused by it [6].

This study is undertaken to find out changes in lung function parameters in healthy smokers in our population. Thus the study will also help us to

document hazards of smoking on lung function parameters.

AIMS AND OBJECTIVES:

- To compare the spirometry findings in smokers and non-smokers.
- To detect impact of smoking index on spirometry findings.

NULL HYPOTHESIS (H0)

There is no significant difference between spirometry findings of smokers and non-smokers.

ALTERNATIVE HYPOTHESIS (H1)

Spirometry findings of smokers and non-smokers show significant difference.

MATERIAL AND METHODS

In this study 300 healthy persons were taken and divided into 2 groups group A and group B. Each group contains 150 patients. The person who smokes is labelled under group A and the person who does not smoke is labelled under group B. Most of the subjects were relatives of the patients accompanying them to OPD or IPD Motilal Nehru Medical College, Allahabad. Spirometry had been performed in these healthy individuals.

Type of the study

Cross-sectional observational

Inclusion criteria

- Individuals giving written consent
- Healthy individuals with no active respiratory complains
- Smoker or non-smoker
- Age between 20 and 60

Exclusion criteria

- Patients having pneumonia, malignancy, tuberculosis or bronchiectasis on CXR
- Known patients of bronchial asthma, COPD, ABPA, IHD, Obesity or any other
- Respiratory condition.
- Industrial worker working in coal or asbestos factory or any other industrial dust
- Exposure.
- Patients with contra-indication to spirometry.43
- Recent thoracic-abdominal surgery
- Recent ophthalmic surgery
- Thoracic or abdominal aneurysm

METHODS

Individuals coming to respiratory medicine OPD/IPD or general medicine OPD/IPD had undergone detailed history taking and clinical examination. Then they were subjected for spirometry.

Test procedure

The technician will provide proper instructions and will demonstrate the manoeuvre prior to the start of testing. The subject is being tested in the sitting position wearing a nose clip and testing results were obtained. After the subject made an airtight seal around the mouthpiece, subject was asked to take a maximal inspiration and then to forcefully expel air for as long and as quickly as possible. Measurements that were included forced expiratory volume in one second (FEV1), forced vital capacity (FVC), the ratio of the two volumes (FEV1/FVC). The tongue and teeth must be positioned so as not to obstruct airflow. An acceptable manoeuvre had been performed with maximal effort without evidence of leakage, hesitation or measurement artefact. The test interval (e.g. 12 s) was reported. A rest between manoeuvres would improve subsequent efforts10. After spirometry we had also measured PEFR by Peak Flow meter.

Sample Size

Total number of 300 persons coming to Motilal Nehru Medical College was selected.

Duration of the study

1.5 months

OBSERVATIONS AND RESULTS

The study was carried out on 150 smokers and 150 non-smokers who came to Motilal Nehru Medical College, Allahabad (UP).

Statistical methods

- Data were collected, tabulated, coded then analysed using SPSS® computer software version 14.0.
- Numerical variables were presented as mean & standard deviation (SD) while categorical variables were presented as percent.
- Student's t test and one way ANOVA were also used.

One way Anova

Is a technique used to compare means of two or more samples? This technique can be used only for numerical data.

p- Value

>0.05	Non-Significant
<0.05	Significant
<0.001	Highly Significant

NULL HYPOTHESIS (H0)

There is no significant difference between spirometry findings of smokers and non-smokers.

ALTERNATIVE HYPOTHESIS (H1)

Spirometry findings of smokers and non-smokers show significant difference. The age of the subjects in the study ranged between 21-45 years. They were grouped into smokers and non-smokers. Out of the 150 non-smoking subjects, 36 persons were in the age group of 21-25 years, 55 were in the age group of 26-30 years, 27 were in the age group of 31-35 years, 29 persons were in the group of 36-40 years and 3 persons were in the group of 41-45 years. (Graph-1) Out of the 150 smoking subjects, 25 persons were in the age group of 21-25 years, 51 were in the age group of 26-30 years, 9 were in the age group of 31-35 years, 58 persons were in the group of 36-40 years and 7 persons were in the group of 41-45 years. (Graph-1).

On analysing the physical characteristics of the 150 non-smoking subjects the mean age (in yrs) is 30.19 ± 5.73; the mean height (in cm) is 166.11 ± 7.38; the mean weight (kg) is 63.01 ± 6.97. (Table-3).

On analysing the physical characteristics of the 150 smoking subjects the mean age (in yrs) is 32.33 ± 6.37; the mean height (in cm) is 166.55 ± 7.48; the mean weight (kg) is 64.83 ± 7.20. (Table-3).

FVC

The Actual Value of FVC in non-smokers was 93.23 ± 6.28% of percentage predicted. The Actual Value of FVC in smokers was 73.77 ± 6.44% of percentage predicted. There was statistically significant decrease in the level of FVC in smokers compared to non-smokers (P < 0.001) (Table 4, Graph 2).

FEV1

The Actual Value of FEV1 in non-smokers was 98.99 ± 7.36% of percentage predicted. The Actual Value of FEV1 in smokers was 69.58 ± 8.15% of percentage predicted. There was statistically significant decrease in the level of FEV1 in smokers compared to non-smokers (P < 0.001) (Table 5, Graph 3).

FEV1/FVC

The Actual Value of FEV1/FVC in non-smokers was 104.69 ± 7.66. The Actual Value of FEV1/FVC in smokers was 92.77 ± 6.31. There was statistically significant decrease in the level of FEV1/FVC in smokers compared to non-smokers (P < 0.001) (Table 6, Graph 4).

FEF 25-75%

The Actual Value of FEF 25-75% in non-smokers was 100.15 ± 9.31% of percentage predicted. The Actual Value of FEF 25-75% in smokers was 68.36 ± 7.39% of percentage predicted. There was statistically significant decrease in the level of FEF 25-75% in smokers compared to non-smokers (P < 0.001) (Table-7, Graph-5).

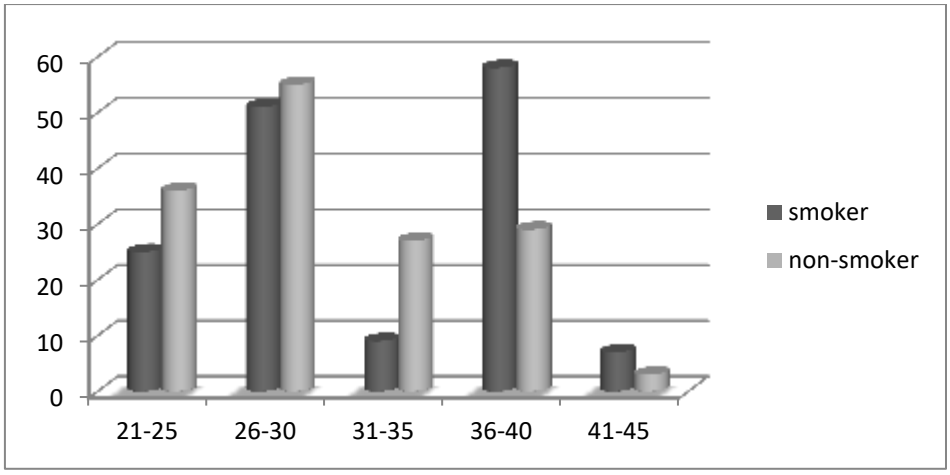
PEFR

The Actual Value of PEFR in non-smokers was 92.69 ± 10.72% of percentage predicted. The Actual Value of PEFR in smokers was 66.94 ± 8.16% of percentage predicted. There was statistically significant decrease in the level of PEFR in smokers compared to non-smokers (P < 0.001) (Table-8, Graph-6).

The percentage predicted of FEV1 (%) in smokers with a smoking index <100 was 92.27 ± 12.49. This value was 67.88± 4.97 in smokers with a smoking index between 101 to 200. In smokers with a smoking index between 201 to 300 FEV1 was 64.95 ± 4.66. FEV_1 was 60.14 ± 3.41 in smokers with a smoking index between 301 to 400 and in smokers with a smoking index >400 FEV1 was 56.5 ± 5.56. It was observed that the level of FEV1 decreased with increase in smoking index. During early phase of smoking FEV1 decreases suddenly. There was statistically significant decrease in the level of FEV1 where smoking index is between 100 to 200. (P < 0.001). (Table 9, Graph 9).

FEF 25-75%

The percentage predicted of FEF 25-75% in smokers with a smoking index <100 was 92.38 ± 14.78. This value was 66.61± 4.51 in smokers with a smoking index between 101 to 200. In smokers with a smoking index between 201 to 300 FEF 25-75% was 64.35 ± 4.35. FEF 25-75% was 60.68 ± 4.11 in smokers with a smoking index between 301 to 400 and in smokers with a smoking index >400 FEF 25-75% was 61.75 ± 2.06. It was observed that the level of FEF 25-75% decreased with increase in smoking index. During early phase of smoking FEF 25-75% decreases suddenly. There was statistically significant decrease in the level of FEF 25-75% where smoking index is between 100 to 200. (P < 0.001). (Table-9, Graph-9).



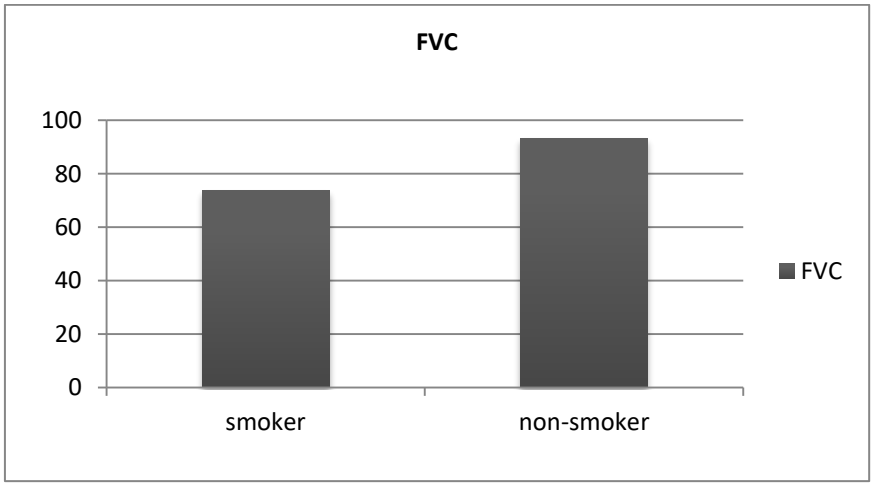
Graph-1: Age wise distribution of smokers and non-smokers

Table-3: Physical characteristics of smokers and non-smokers

	Group	N	Mean	Std. Devi	Std. Error	95% Confidence Interval for Mean		Mini mum	Maxi mum
						Lower Bound	Upper Bound		
Age(year)	Smokers	150	32.33	6.37	.521	31.30	33.36	21	45
	Non Smokers	150	30.19	5.73	.468	29.26	31.11	21	42
	Total	300	31.26	6.14	.355	30.56	31.96	21	45
Height(cm)	Smokers	150	166.55	7.48	.611	165.35	167.76	143	180
	Non Smokers	150	166.11	7.38	.603	164.92	167.30	148	185
	Total	300	166.33	7.42	.429	165.49	167.18	143	185
Weight(kg)	Smokers	150	64.83	7.20	.588	63.67	66.00	48	86
	Non Smokers	150	63.01	6.97	.569	61.89	64.14	45	86
	Total	300	63.92	7.13	.412	63.11	64.73	45	86

Table-4: Comparison of FVC in smokers and non-smokers

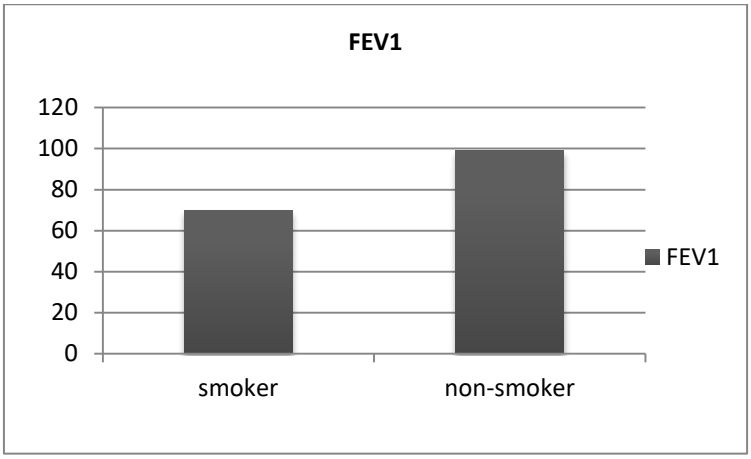
	Group	N	Mea	St d. De	St d.	95% Confidence Interval for Mean		Mi ni	M ax	p-va lu
						Lower Bound	Upper Bound			
FVC	Smokers	150	73.77	6.44	.526	72.73	74.81	54	106	<0.001
	Non Smokers	150	93.23	6.28	.513	92.22	94.25	78	118	
	Total	300	83.50	11.63	.672	82.18	84.82	54	118	



Graph-2: Comparison of FVC in smokers and non-smokers

Table-5: Comparison of FEV1 in smokers and non-smokers

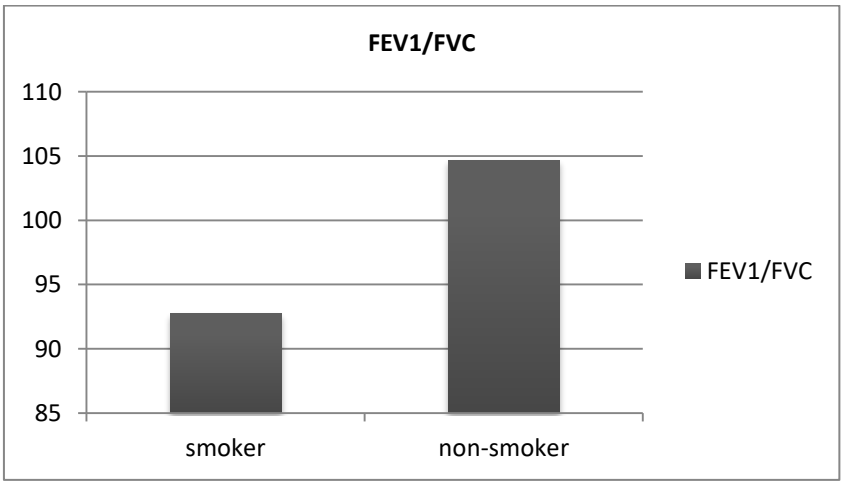
	Group	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum	p-value
						Lower Bound	Upper Bound			
FEV1	Smokers	150	69.58	8.15	.665	68.27	70.89	49	103	<0.001
	Non Smokers	150	98.99	7.36	.601	97.80	100.18	83	131	
	Total	300	84.28	16.64	.961	82.39	86.17	49	131	



Graph-3: Comparison of FEV1 in smokers and non-smokers

Table-6: Comparison of FEV1/FVC in smokers and non-smokers

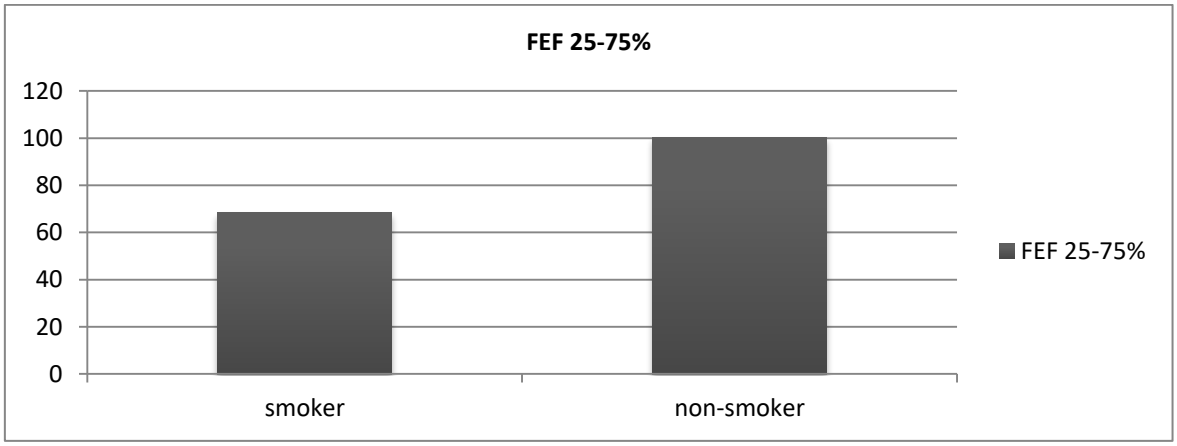
	Group	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum	p-value
						Lower Bound	Upper Bound			
FEV1/ FVC	Smokers	150	92.77	6.31	.516	91.75	93.79	60	102	<0.001
	Non Smokers	150	104.69	7.66	.626	103.45	105.92	82	123	
	Total	300	98.73	9.20	.532	97.68	99.77	60	123	



Graph-4: Comparison of FEV1/FVC in smokers and non-smokers

Table-7: Comparison of FEF25-75% in smokers and non-smokers

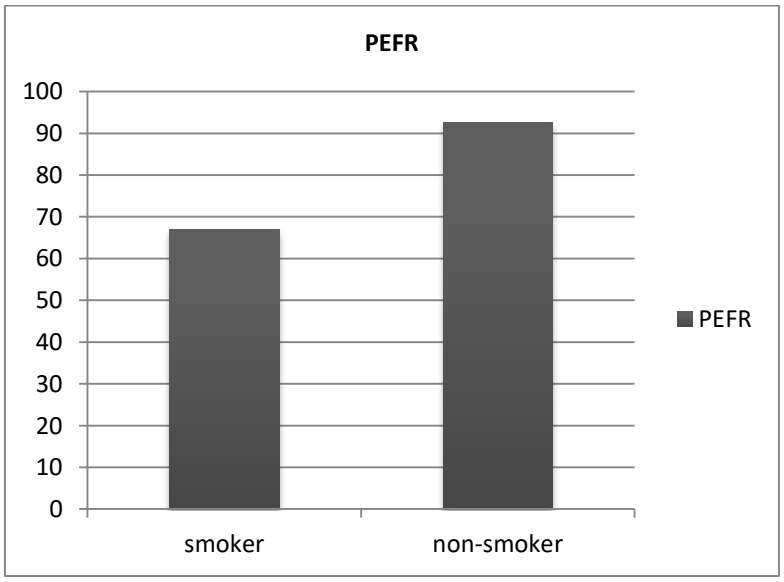
	Group	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum	p-value
						Lower Bound	Upper Bound			
FEF 25-75%	Smokers	150	68.36	7.39	.604	67.17	69.55	51	102	<0.001
	Non Smokers	150	100.15	9.31	.761	98.65	101.66	83	141	
	Total	300	84.26	18.00	1.039	82.21	86.30	51	141	



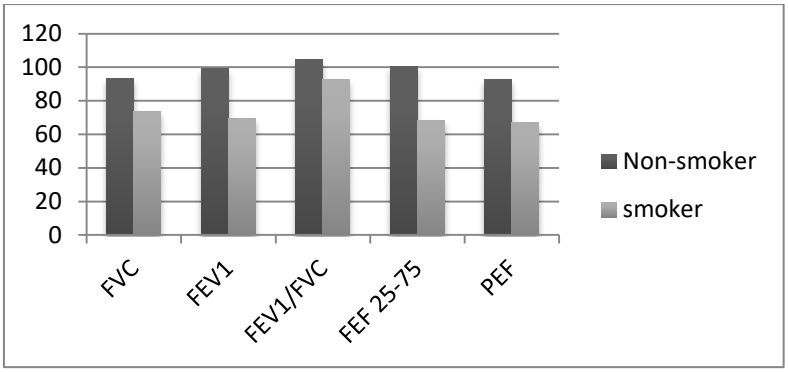
Graph-5: Comparison of FEF25-75% in smokers and non-smokers

Table-8: Comparison of PEFR in smokers and non-smokers

	Group	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum	p-value
						Lower Bound	Upper Bound			
PEFR	Smokers	150	66.94	8.16	.667	65.62	68.26	53	97	<0.001
	Non Smokers	150	92.69	10.72	.875	90.96	94.42	78	195	
	Total	300	79.81	16.02	.925	77.99	81.63	53	195	



Graph-6: Comparison of PEFR in smokers and non-smokers



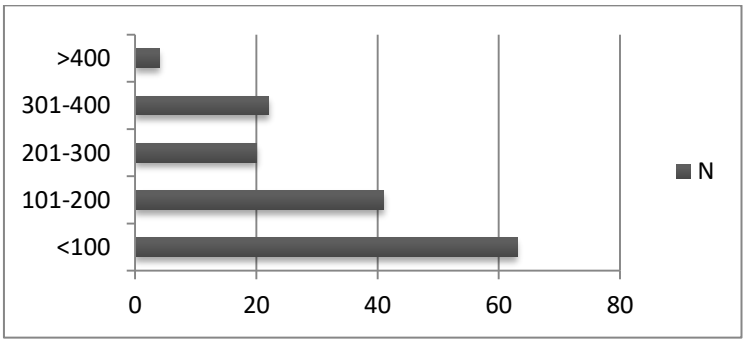
Graph-7: Comparison of spirometry in smokers and non-smokers

After comparing these five parameters of spirometry in smokers and non-smokers the P value ($p < 0.001$), we are getting, is highly significant so we are rejecting null hypothesis (H_0) and accept alternate hypothesis (H_1) that Spirometry findings of smokers and non-smokers show significant difference.

Spirometry and smoking index:

According to smoking index we have divided smokers in 5 groups.

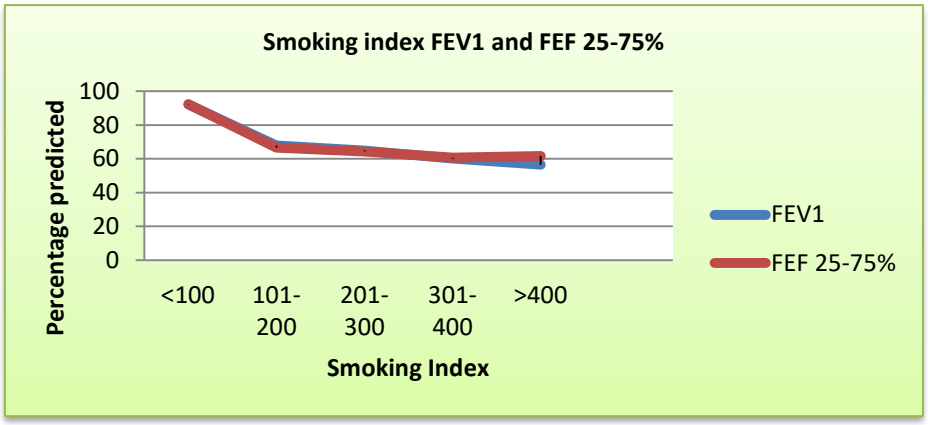
Groups	Smoking Index	N
Group 1	<100	63
Group 2	101-200	41
Group 3	201-300	20
Group 4	301-400	22
Group 5	>400	4



Graph-8: Number of smokers in a group according to smoking index

Table-9: Comparison of FEV1 and FEF 25-75% in smokers with different smoking index

	Smoking Index	N	Mean	Std. Dev	Std. Err	95% Confidence Interval for Mean		Min	Max
						Lower Bound	Upper Bound		
FEV1	<100	213	92.27	12.49	.856	90.59	93.96	65	131
	101-200	41	67.88	4.97	.777	66.31	69.45	58	88
	201-300	20	64.95	4.66	1.042	62.77	67.13	54	75
	301-400	22	60.14	3.41	.728	58.62	61.65	50	66
	>400	4	56.50	5.56	2.784	47.64	65.36	49	62
	Total	300	84.28	16.64	.961	82.39	86.17	49	131
FEF 25-75%	<100	213	92.38	14.78	1.013	90.38	94.38	56	141
	101-200	41	66.61	4.51	.704	65.19	68.03	56	77
	201-300	20	64.35	4.35	.974	62.31	66.39	59	74
	301-400	22	60.68	4.11	.876	58.86	62.50	51	71
	>400	4	61.75	2.06	1.031	58.47	65.03	59	64
	Total	300	84.26	18.00	1.039	82.21	86.30	51	141



Graph-9: Comparison of FEV1 and FEF 25-75% in smokers with different smoking index

There is significant decrease in FEV1 and FEF 25-75% with increase in smoking index. ($P < 0.001$)

DISCUSSION

Tobacco smoking is the major preventable cause of death in many parts of the world. Tobacco related lung diseases and cardiovascular diseases cause a significant proportion of total deaths and chronic disability.

Our study "Comparison of spirometry findings among smokers and non-smokers" analyses the effect of cigarette smoking on lung functions of an individual. Pulmonary function tests were performed on 300 male subjects who were divided into 2 groups, 150 smokers and 150 non-smokers. All the subjects were in between the age group of 21-45 years.

Smokers were again grouped into many groups based on smoking index. The differences in the mean value of each parameter between smokers and non-smokers and the difference in each parameter in smokers based on smoking index were analysed and discussed.

In our study there was a statistically significant decrease in the value of FVC in smokers compared to non-smokers. Similar findings were also reported in studies by Sunita Nighute *et al.* [7] (4.19% decrease in percentage predicted of FVC), Rubina Bano *et al.*[8] (4.79% decrease in percentage predicted of FVC), Nancy NR *et al.*[9] and Mhase VT *et al.*[14].

In our study there was a statistically significant decrease in the value of FEV1 in smokers compared to non-smokers. Similar findings were also reported from Sunita Nighute *et al.*[7] (15.49% decrease in percentage predicted of FEV1), Rubina Bano *et al.*[8] (11.74% decrease in percentage predicted of FEV1), Hogg CJ *et al.*[11] and Kerstjens *et al.*[12].

In our study there was a statistically significant decrease in the level of ratio of FEV1/FVC. Smokers showed a decrease of ratio by 11.92 when compared to non-smokers. It also showed that ratio of FEV1/FVC was more decreased with increase in smoking index. These findings are similar to studies from Sunita Nighute *et al.*[7] (4.55% decrease in FEV1/FVC ratio), Rubina Bano *et al.*[8] (5.56% decrease in FEV1/FVC ratio), Walter S *et al.*[13] and Gold RD *et al.*[11].

In our study the level of forced expiratory flow between 25% and 75% of FVC or average forced expiratory flow was reduced by 31.79% in smokers compared to non-smokers. Similar findings were also reported from Sunita Nighute *et al.* [7] (18.84% decrease in percentage predicted of FEF25-75%), Rubina Bano *et al.*[8](16.71% decrease in percentage predicted of FEF25-75%), Nancy NR *et al.*[9], Walter S *et al.*[13] and Mhase VT *et al.*[14].

Our study has shown a statistically significant decrease in the value of PEFR (25.75% of percentage predicted). It has also shown that, the PEFR decreases more with increase in smoking index. These findings were similar to those reported by Sunita Nighute *et al.*[7] (26.03% decrease in percentage predicted of PEFR), Rubina Bano *et al.*[8] (22.05% decrease in percentage predicted of PEFR) and Nancy *et al.*[9].

As it is shown in our study, all the parameters of lung function which are analysed showed a decrease in their value, with an increase in smoking index. It was shown, that the effect was very much dependent upon the extent of exposure as per our study smoking index.

The progressive nature of these changes with continued smoking indicates that at least a proportion of these smokers may go on to develop chronic obstructive airways diseases [11].

CONCLUSION

The following conclusion can be drawn from the results of our study.

- The actual values of FVC, FEV1, ratio of FEV1/ FVC, FEF25-75% and PEFR are decreased in smokers compared to non-smokers. Thus showing causal relationship.
- All the values are further more decreased with increase in smoking index. Thus showing a dose response relationship.
- There is significant decrease in lung function parameters like FEV1 and FEF 25-75% when smoking index is between 100 - 200.
- Among all the parameters, value of FEF25-75% has decreased more, showing that smoking first affects the small conducting airway, where disease of chronic airflow obstruction is thought to originate.
- Healthy smokers having low smoking index also develop changes in pulmonary functions indicating early peripheral airway narrowing or inflammation, and these effects worsen progressively with continued smoking.
- In spite of no symptoms, smokers were found to have significant reduction in lung function parameters. So with help of spirometry findings we can guide and encourage them to quit smoking to prevent progression of disease.
- Further research is recommended to study the effects of cessation of smoking on lung functions.

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