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TITLE

AUTHOR

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I. Introduction

Tobacco smoking and tuberculosis are two major global public health problems. Chronic exposure to tobacco, as well as to a number of environmentalpollutants, damages the normal clearance mechanism of secretion on the trachea-bronchial mucosal surface. This may allow the causative organism Mycobacterium tuberculosis, to escape the first level of host defenses, which prevent bacilli from reaching the alveoli. Smoke also impairs the function of pulmonary alveolar surfactants and impairs the Lung immunity.[1,2,3,4] Tuberculosis has been classically associated with poverty, overcrowding and malnutrition. All these factors mentioned are present in India more than any nation.

Tuberculosis (TB) is an airborne infectious disease caused by group of organisms of the Mycobacterium tuberculosis complex. One third of the world's population is infected with Mycobacterium tuberculosis, although the organism is controlled by the immune system in maximum of these persons. It has long been suggested that tobacco smoking may influence rates of TB morbidity and mortality. Smoking increases the risk of contracting tuberculosis (TB), increases the risk of recurrent TB and impairs the response to treatment of the disease.[5,6,7,8]

Even with satisfactory management with anti-tuberculosis medications the course of restorative outcomes in a diverse squeal such as fibrosis, cavitations, bronchiectasis, bull and calcification which could lead to several clinical features and transformed lung function. These patients typically show symptoms such as dyspnea, cough with sputum production, wheeze, fever and hemoptysis.[9,10,11]

Currently the functional injury because of several tuberculosis sequels is considered with tests such as six minute walk test or the shuttle walk test. Spirometry is used to measure the lung function. These tests help to determine the severity of the impairment and to evaluate the quality of life in these patients. These tests also help in scheduling the lung rehabilitation for these patients which could rise the quality of life.

The six-minute walk test more or less reflects the ability of the patients to perform their daily life activities than the laboratory tests, and it is also well tolerated by majority of the patients. Smoking has been proved to cause a decrease in lung function by many numbers of mechanisms.

Smoking is a predominant risk factor that affects particularly the respiratory and cardiovascular systems leading to many respiratory disorders or it may aggravate the respiratory symptoms. This study is done to find if there is any significant relationship between the decreased lung function or exercise capacity due to smoking in addition to the effects caused by the tuberculosis sequelae. This information may be used to explain the harm of smoking and to encourage the people to quit smoking.

Various studies have been on this topic and proved the negative impacton the outcome in Tb treatment. Cigarette smoking causes delay in culture conversion during therapy and frequently requiring treatment extension and multiple hindrance in management of patients. Even though India carries the global burden of tuberculosis, Studies in Indian Context are scanty and fail to explore the various factors associated. This study aims to address this context especially in South India.

II. Aims And Objectives

Aim:

To compare the respiratory function among the treated pulmonary tuberculosis patients with sequel among smokers and non-smokers.

Objectives:

1. To compare the spirometry values in treated pulmonary tuberculosis patients among smokers andnon-smokers.

2. To compare the six-minute walk distance in treated pulmonary tuberculosis patients among smokers andnon-smokers.

3. To assess the overall functional status in treated pulmonary tuberculosis patients presenting with sequel

among smokers and non-smokers.

III. Methodology

Study site: This study was conducted in the Department of Respiratory medicine, KIMS, Amalapuram..
Study population: 100 patients attending outpatient department of pulmonary medicine.
Study design: The current study was a prospective cross-sectional study.
Sample size: 100 patients.
Sampling method: All patients were randomly allocated into following groups:

Group I – Smokers (n=45)
Group II – non-smokers (n=55).

Study duration: The present study was conducted during the period of 12 months from January 2020 to December 2021.
Inclusion criteria:

1. Patients who were previously treated as sputum positive tuberculosis and completed treatment according to the guidelines of RNTCP.
2. Sputum smears for AFB negative at present.
3. Chest x-ray showing tuberculosis sequel.

Exclusion criteria:

1. Patients with blood pressure more than 180/120 mm of hg.
2. Resting heart rate more than 120 per minute.
3. Patients with chest pain.
4. Patients with vascular/musculoskeletal abnormalities in lower extremities.
5. Patients with respiratory failure.
6. History of cardiac or abdominal surgery within six months.

Ethical consideration:
Study was approved by institutional human ethics committee. Informed written consent was obtained from all the study participants and only those participants willing to sign the informed consent were included in the study. The risks and benefits involved in the study and voluntary nature of participation were explained to the participants before obtaining consent. Confidentiality of the study participants was maintained.

Methodology:

100 patients were included and informed written consent is obtained from all the patients. Detailed history of the patients was obtained regarding the symptoms, previous anti tubercular treatment history, smoking history. Chest X-ray was done in all the patients and the lung filed was divided into 6 zones. Spirometry and six minute walk test were conducted in the sameday.Patients were grouped into two groups as smokers and non-smokers.
Severity of smoking was assessed using 'Smoking Index' (SI). It is defined the number of beedi or cigarettes smoked per day that is multiplied by duration of smoking in years. Smokers were categorized as**:**

- Mild smokers(SI<100)
- Moderate smokers(SI=100-300)
- Heavy smokers (SI>300)

6-minute walk test:
The test was carried out as cited by the American Thoracic Societyguideline.

- 30 meter long hospital corridor was selected and every meteris marked by a line.
- Participants were explained about the use of the test andwere instructed to walk in their normal pace from one end tothe other end and to cover as much distance as possible duringthe six minute time. Encouragement through words was notdone while the patient was walking and only the left overduration was pointed out every minute.
- Participants were permitted to stop in case they developed anysymptoms like chest pain, giddiness or leg cramps.
- They were allowed to continue the walk if it was possible forthem. The distance covered was recorded at 2, 4, and 6minutes.
- Heart rate, blood pressure, oxygen saturation and Borgdyspnea scale were recorded both before and after completionof the test.

Study tools:

- Table of randomization**.**
- Consent form**.**
- Computerized spirometer.
- Disposable mouth pieces.
- Stop watch.
- Sphygmomanometer.
- Measuring tape.
- Chalk.
- Pulse oximeter.

Statistical methods:

Descriptive analysis was carried out by mean and standard deviation for quantitative variables, frequency and proportion for categorical variables. Data was also represented using appropriate diagrams like bar diagram, pie diagram and box plots.

All Quantitative variables were checked for normal distribution within each category of explanatory variable by using visual inspection of histograms and normality Q-Q plots. Statistical analysis was made with IBM SPSS 16.0 software and P value of <0.05 was considered significant.

One way ANOVA test is used for Continuous variables like

- Age.
- Body MassIndex.
- Spirometry results.
- 6 minute walk test distance.

Pearson's Chi-squared test is used for Categorical variables like

- Gender.
- Symptoms.
- ATT category.
- Side involved in chest x-ray.
- Zone involved in radiology.
- Pattern of spirometry.

IV. Results

A prospective cross sectional study was done among 100 patients satisfying inclusion and exclusion criteria attending outpatient department of pulmonology with history of pulmonary tuberculosis and completed treatment in KIMS, Amalapuram during the study period of 12 months after obtaining informed consent.

Table 1: Distribution of patients according to smoking history among the study population (n=100):

Smoking	N	%
Yes	45	45.0
No	55	55.0
Total	100	100.0

In present study, among 100 patients 55% of patients were non-smokers and 44% of patients were smokers.

Chart 1: Pie chart showing distribution ofpatients according to smoking history among the study population:

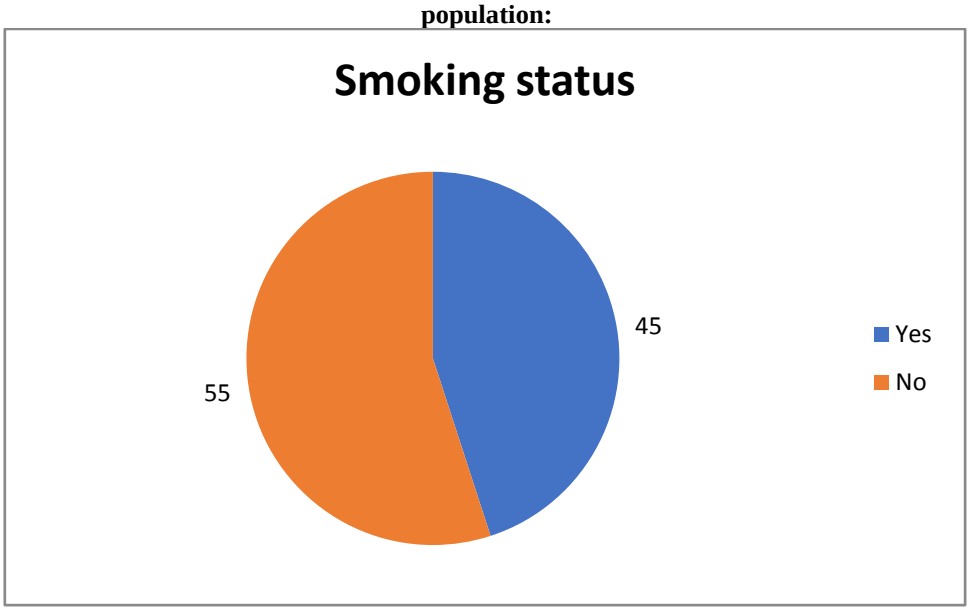

Table 2: Distribution of age of patients among the study population (n=100):

Age (years)	Smokers (n=45)		Non-smokers (n=55)	
	N	%	N	%
20 – 29	0	0.0	2	3.6
30 – 39	2	4.4	9	16.4
40 – 49	5	11.2	11	20.0
50 – 59	14	31.1	16	29.1
60 – 69	18	40.0	14	25.5
≥ 70	6	13.3	3	5.4
Total	45	100.0	55	100.0
Mean ± SD	59.33 ± 10.07 years		53.64 ± 12.38 years	
Range	34 – 78 years		27 – 80 years	
P value	0.015			

In present study, majority of patients (40%) belong to age group of 60 to 69 years followed by 31.1% of patients belong to age group of 50 to 59 years, 13.3% of patients were of more than 70 years, 11.2% of patients belong to age group of 40 to 49 years and 4.4% of patients belong to age group of 30 to 39 years with mean age of 59.33 ± 10.07 years and range of 34 to 78 years among the smokers group. Majority of patients (29.1%) belong to age group of 50 to 59 years followed by 25.5% of patients belong to age group of 60 to 69 years, 20% of patients belong to age group of 40 to 49 years, 16.4% of patients belong to 30 to 39 years, 5.4% of patients belong to age group of more than 70 years and 3.6% of patients belong to age group of 20 to 29 years with mean age of 53.64 ± 12.38 years and range of 27 to 80 years among non-smokers group.

Chart 2: Cluster bar chart showing distribution of age of patients among the study population:

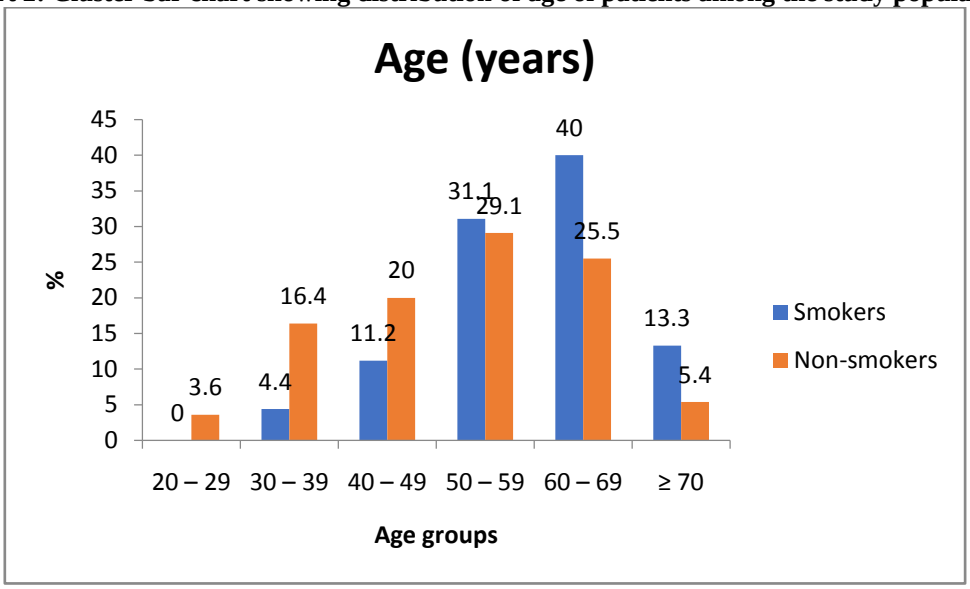

Table 3: Distribution of gender of patients among the study population (n=100):

Gender	Smokers (n=45)		Non-smokers (n=55)	
	N	%	N	%
Males	45	100.0	32	58.2
Females	0	0.0	23	41.8
Total	45	100.0	55	100.0

In present study, among the smokers all the patients were males (100%) whereas among the non-smokers groups, 58.2% of patients were males and 41.8% of patients were females.

Chart 3: Cluster bar chart showing distribution of gender of patients among the study population:

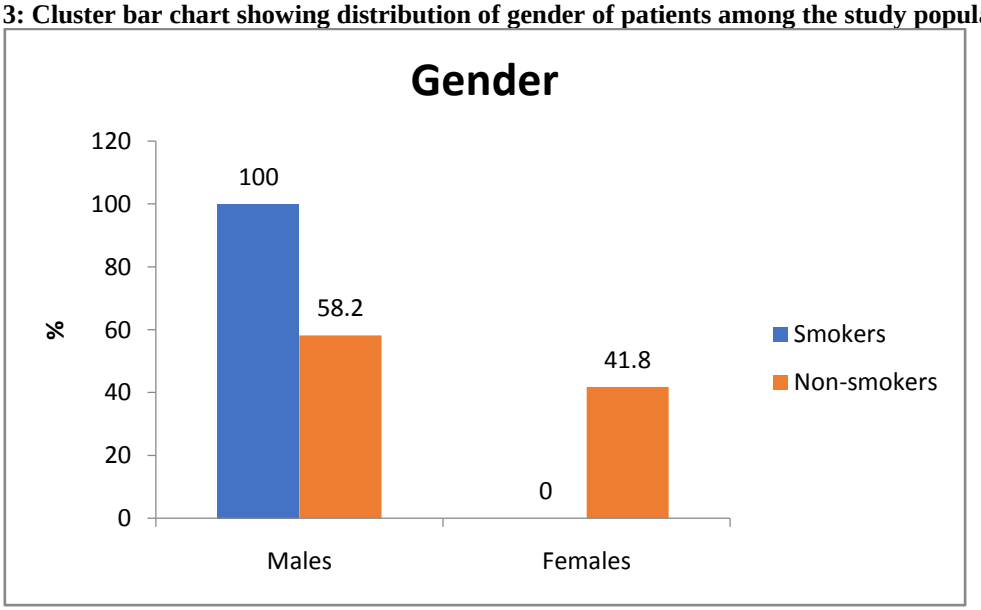

Table 4: Distribution of symptoms among the study population (n=100):

Symptoms	Smokers (n=45)		Non-smokers (n=55)	
	N	%	N	%
Cough	44	97.8	44	80.0
Sputum	38	84.4	32	58.2
Chest pain	2	4.4	0	0.0
Dyspnea	43	95.6	27	49.1
Wheeze	11	24.4	6	10.9

In present study, 97.8% of patients had cough, 84.4% of patients had sputum production, 4.4% of patients had chest pain, 95.6% of patients had breathlessness and 24.4% of patients had wheeze among smokers group. 80% of patients had cough, 58.2% of patients had sputum production, 49.1% of patients had breathlessness and 10.9% of patients had wheeze among non-smokers group.

Chart 4: Cluster bar chart showing distribution of symptoms among the study population:

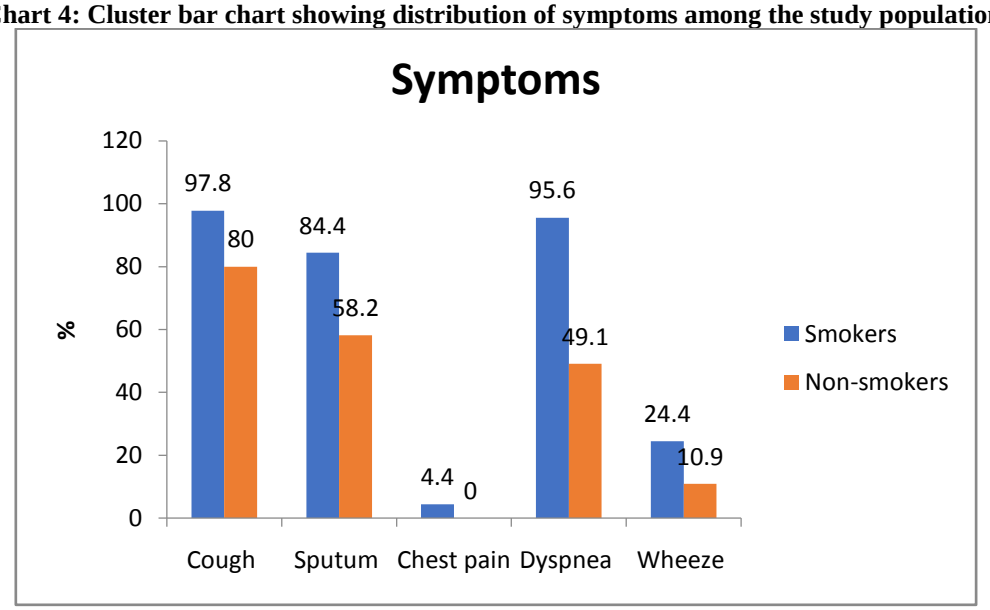

Table 5: Distribution of patients according to smoking index among smoking population (n=45):

Smoking index	N	%
<100	1	2.2
100 – 300	8	17.8
>300	36	80.0
Total	45	100.0

In present study, majority of patients (80%) had smoking index of more than 300, 17.8% of patients had smoking index of 100 to 300 and 2.2% of patients had smoking index of less than 100 among the smokers group.

Chart 5: Pie chart showing distribution of patients according to smoking index among smoking population:

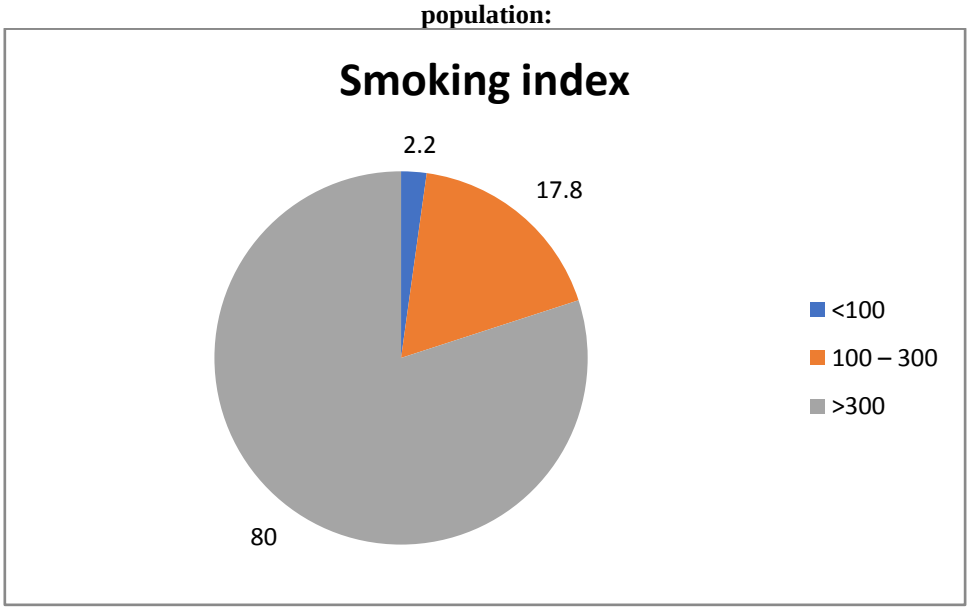

Table 6: Distribution of mean height of patients among the study population (n=100):

Parameter	Smokers (n=45)		Non-smokers (n=55)	
	Mean	SD	Mean	SD
Height (cm)	159.71	6.29	156.91	9.46

In present study, the mean height of patients among smokers was 159.71 ± 6.29cm whereas among non-smokers was 156.91 ± 9.46cm.

Chart 6: Bar chart showing distribution of mean height of patients among the study population:

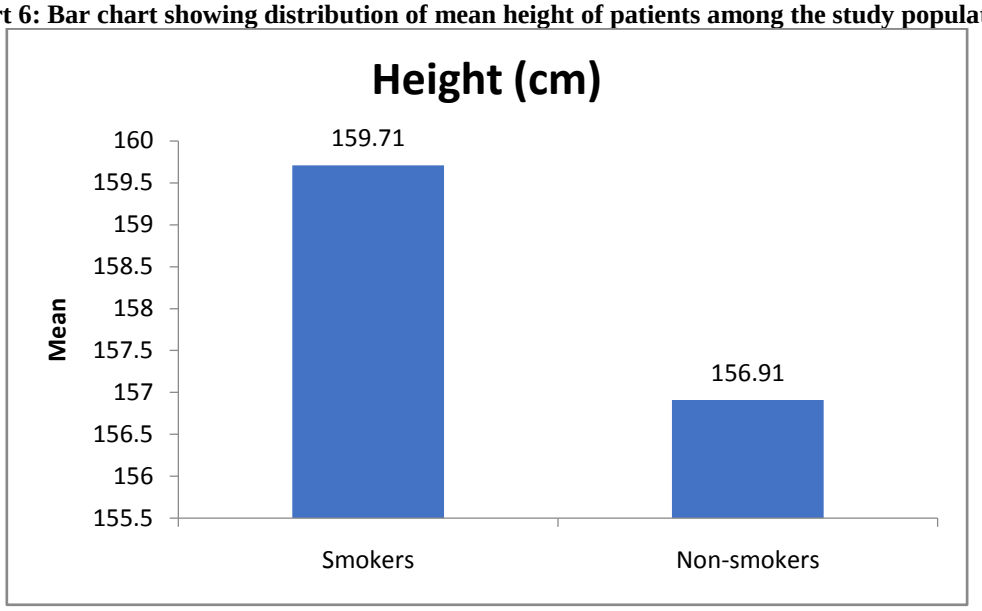

Table 7: Distribution of mean weight among the study population (n=100):

Parameter	Smokers (n=45)		Non-smokers (n=55)	
	Mean	SD	Mean	SD
Weight (kg)	53.29	8.46	50.29	11.35

In present study, the mean weight of patients among smokers was 53.29 ± 8.46kg whereas among non-smokers was 50.29 ± 11.35kgs.

Chart 7: Bar chart showing distribution of mean weight among the study population:

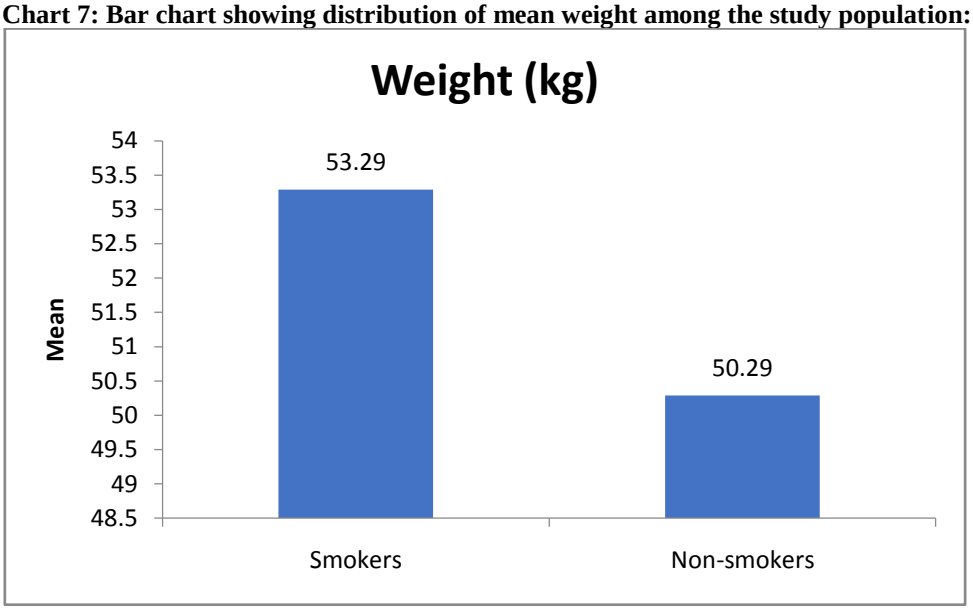

Table 8: Distribution of body mass index among the study population (n=100):

BMI	Smokers		Non-smokers	
	N	%	N	%
Under-weight	10	22.2	22	40.0
Normal	32	71.1	25	45.5
Over-weight	3	6.7	8	14.5
Total	45	100.0	55	100.0
Mean ± SD	20.62 ± 3.30kg/m2		20.45 ± 4.04kg/m2	

Among the patients in smokers group, 71.1% of patients had normal body mass index, 22.2% of patients were under-weight and 6.7% of patients were over-weight with mean BMI of 20.62 ± 3.30kg/m2. Among the patients in non-smokers group, 45.5% of patients had normal body mass index, 40% of patients were under-weight and 14.5% of patients were over-weight with mean BMI of 20.45 ± 4.04kg/m2.

Chart 8: Cluster bar chart showing distribution of body mass index among the study population:

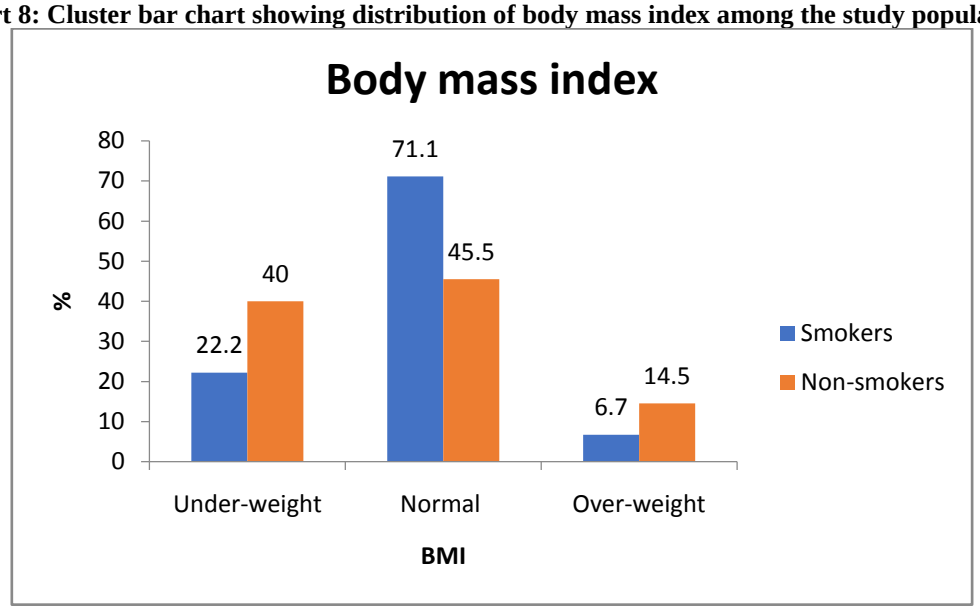

Table 9: Distribution of patients according ATT category among the study population (n=100):

ATT category	Smokers (n=45)		Non-smokers (n=55)	
	N	%	N	%
CAT I	16	35.6	45	81.8
CAT II	29	64.4	10	18.2
Total	45	100.0	55	100.0
Chi square	22.27			
P value	<0.0001			

In present study, among 45 smokers patients 64.4% of patients belong to category II and 35.6% of patients belong to category II of ATT. Among the patients in non-smokers group, 81.8% of patients belong to category I and 18.2% of patients belong to category II of ATT. There statistical significance (P value <0.0001).

Chart 9: cluster bar chart showing distribution of patients according ATT category among the study population:

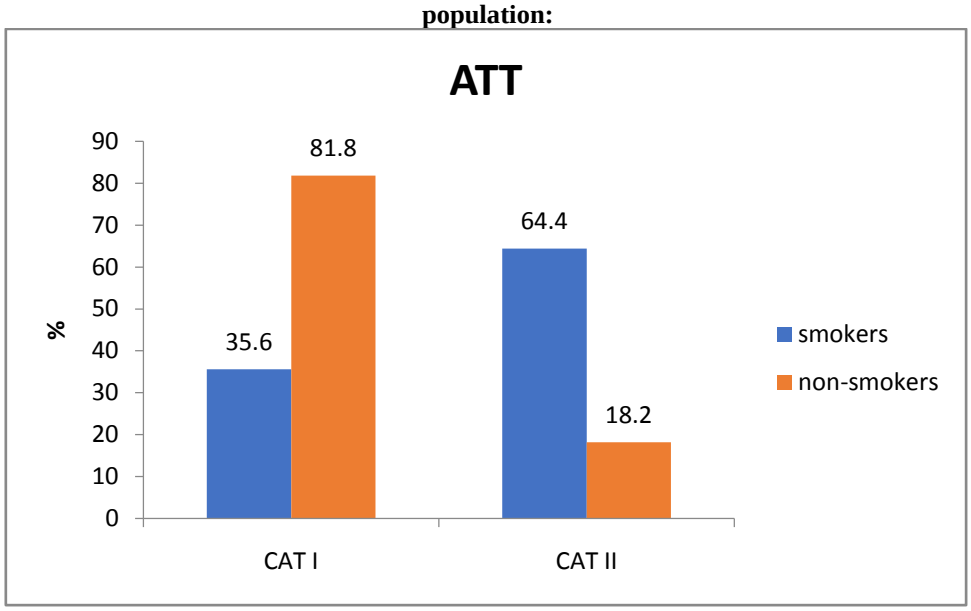

Table 10: Comparison of patients with ATT category with spirometry parameters and 6MWT among the study population (n=100):

Spirometry	ATT	N	Mean	SD	P value
FVC	**CAT I**	61	2.21	0.54	0.000
	CAT II	39	1.79	0.54	
FEV1	**CAT I**	61	1.64	0.45	<0.0001
	CAT II	39	1.06	0.47	
FEV1-FVC	**CAT I**	61	75.05	14.12	0.000
	CAT II	39	60.57	13.14	
PEF	**CAT I**	61	3.95	4.98	0.049
	CAT II	39	2.07	1.24	
6 MWT	**CAT I**	61	363.48	35.38	<0.0001
	CAT II	39	312.69	39.43	

In present study, all the spirometry parameters such as FVC, FEV1, FEV1/FVC and PEF and 6 minute walk test distance was reduced among patients with multiple treatments when compared with CAT I patients which was statistically significant (P value <0.05).

Chart 10A: Cluster bar chart showing comparison of patients with ATT category and spirometry parameters among the study population:

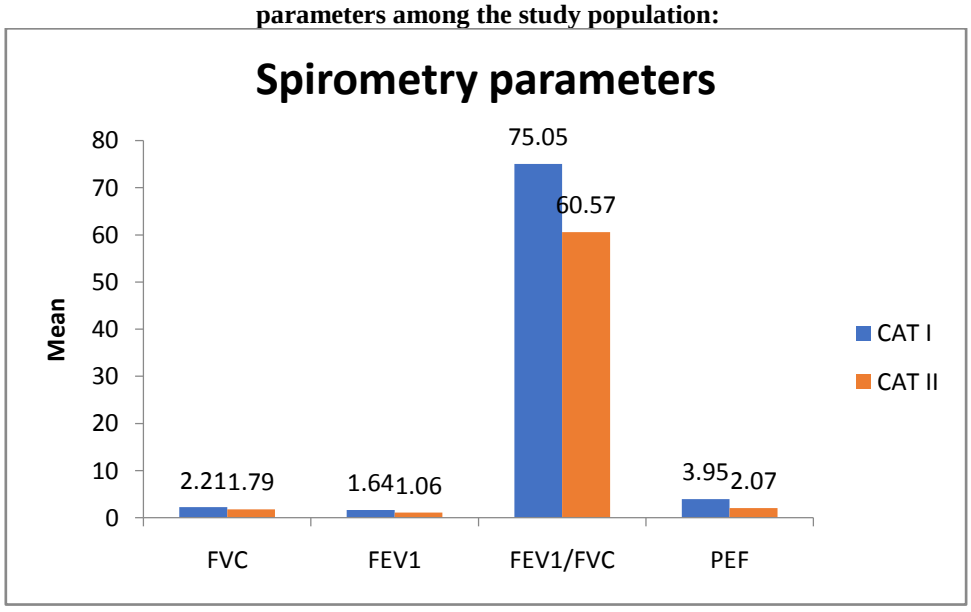

Chart 10B: Bar chart showing comparison of patients with ATT category and 6 minute walk test distance among the study population (n=100):

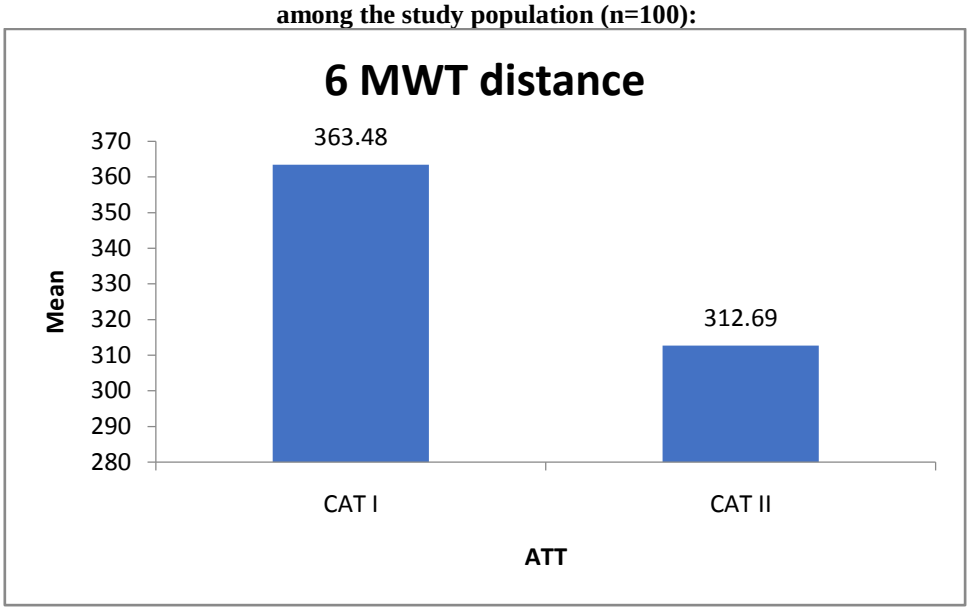

Table 11: Comparison of side involvement in chest X ray among the study population (n=100):

Side involvement	Smokers		Non-smokers	
	N	%	N	%
Unilateral	25	55.6	51	92.7
Bilateral	20	44.4	4	7.3
Total	45	100.0	55	100.0

In present study, 55.6% of smoking patients had unilateral lesions and 44.4% of smoking patients had bilateral lesion whereas 92.7% of non-smoking patients had unilateral lesions and 7.3% of non-smoking patients had bilateral lesions in chest X-ray.

Chart 11: Cluster bar chart showing comparison of side involvement in chest X ray among the study population:

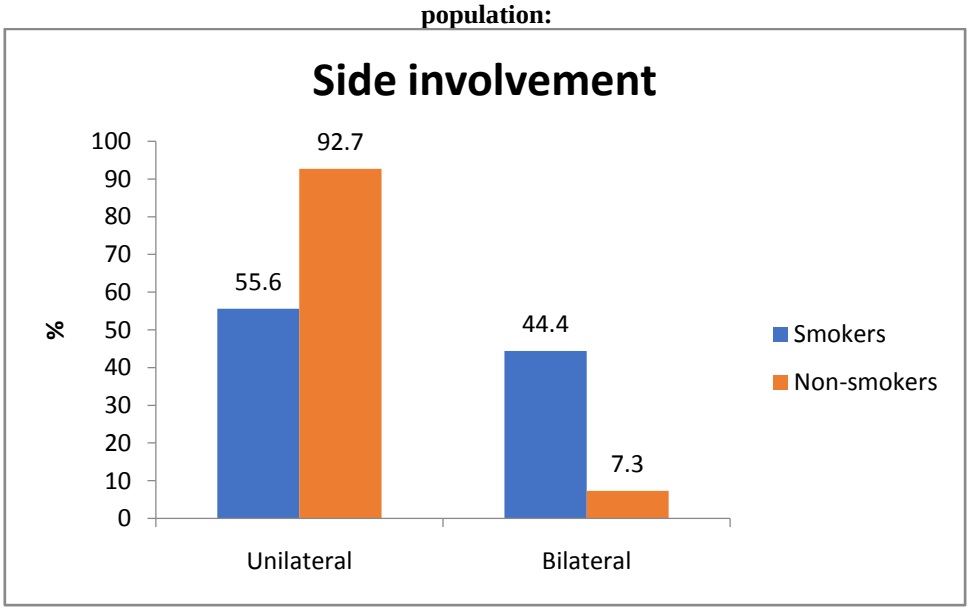

Table 12: Comparison of Chest X-ray lesions with spirometry and 6MWT among the study population (n=100):

Spirometry	Side	N	Mean	SD	P value
FVC	**U/L**	76	2.17	0.53	0.000
	B/L	24	1.66	0.54	
FEV1	**U/L**	76	1.57	0.46	<0.0001

	B/L	24	1.01	0.44	
FEV1-FVC	**U/L**	76	72.93	14.43	0.000
	B/L	24	60.03	11.92	
PEF	**U/L**	76	3.69	4.52	0.045
	B/L	24	1.81	0.91	
6 MWT	**U/L**	76	358.01	33.65	<0.0001
	B/L	24	298.25	44.44	

In present study, all the spirometry parameters such as FVC, FEV1, FEV1/FVC and PEF and 6 minute walk test distance was reduced among patients with bilateral lesions when compared with patients with unilateral lesions which was statistically significant (P value <0.05).

Chart 12A: Cluster bar chart showing comparison of patients with side of lesions and spirometry parameters among the study population:

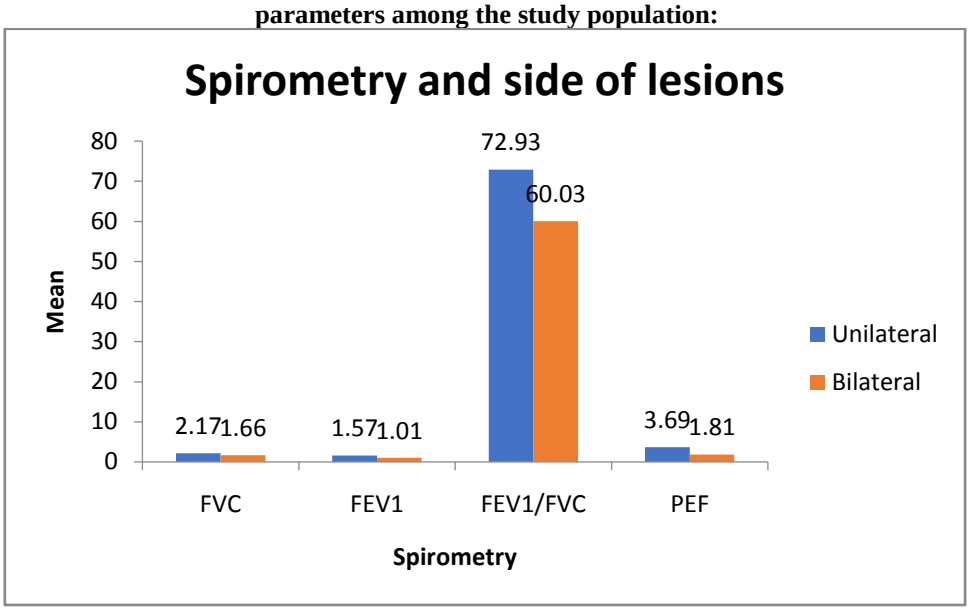

Chart 12B: Bar chart showing comparison of patients with side of lesions and 6 minute walk test distance among the study population:

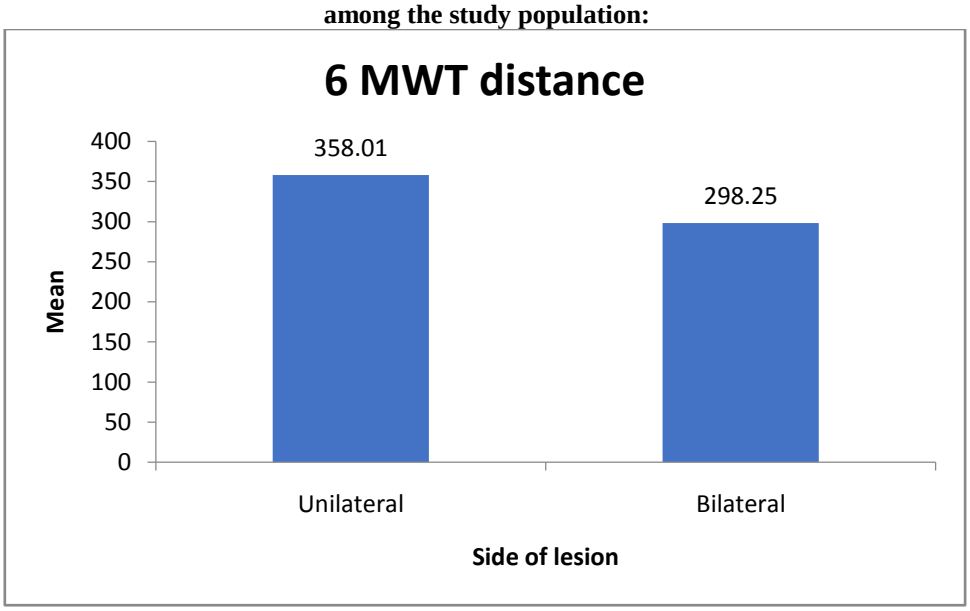

Table 13: Distribution of chest X-ray patterns among the study population (n=100):

Patterns	**Smokers (n=45)**		**Non-smokers (n=55)**	
	N	**%**	**N**	**%**
Fibrosis	31	68.9	33	60.0
Collapse	7	15.6	0	0.0

Cavitation	15	33.3	8	14.5
Bronchiectasis	25	55.6	23	41.8
Combined	29	64.4	16	29.1

In present study, 68.9% of patients had fibrosis, 15.6% of patients had collapse, 33.3% of patients had cavitation, 55.6% of patients had bronchiectasis and 64.4% of patients had combined x-ray patterns in the chest among patients of smokers group whereas 60% of patients had fibrosis, 14.5% of patients had cavitation, 41.8% of patients had bronchiectasis and 29.1% of patients had combined patterns in x-ray of chest among patients of non-smokers group.

Chart 13: Cluster bar chart showing distribution of chest X-ray patterns among the study population:

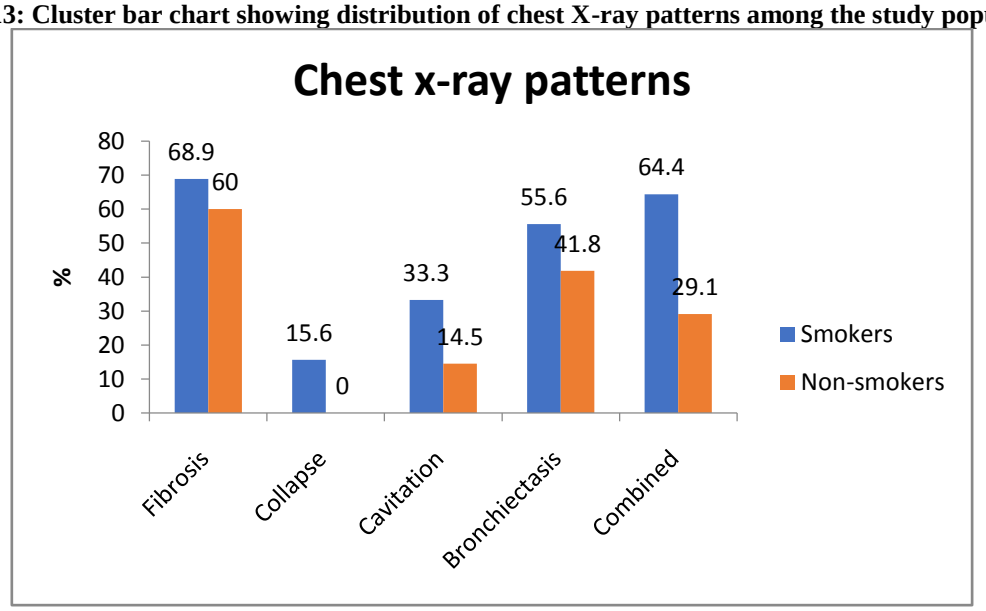

Table 14: Distribution of patients according to the zone involved among the study population (n=100):

No of Zones	**Smokers (n=45)**		**Non-smokers (n=55)**	
	N	**%**	**N**	**%**
1	10	22.2	41	74.5
2	18	32.7	13	23.6
3	11	20.0	1	1.8
4	6	10.9	0	0.0
Total	45	100.0	55	100.0
Chi square	33.32			
P value	<0.0001			

In present study among smoking group, 32.7% of patients had 2 zones involvement followed by 22.2% of patients had one zone involvement, 20% of patients had 3 zones involvement and 10.9% of patients had 4 zones involvement. Among the patients of non-smokers group, 74.5% of patients had one zone involvement, 23.6% of patients had 2 zones involvement and 1.8% of patients had 3 zones involvement. The p value was <0.0001 which was statistically significant.

Chart 14: Cluster bar chart showing distribution of patients according to the zone involved among the study population:

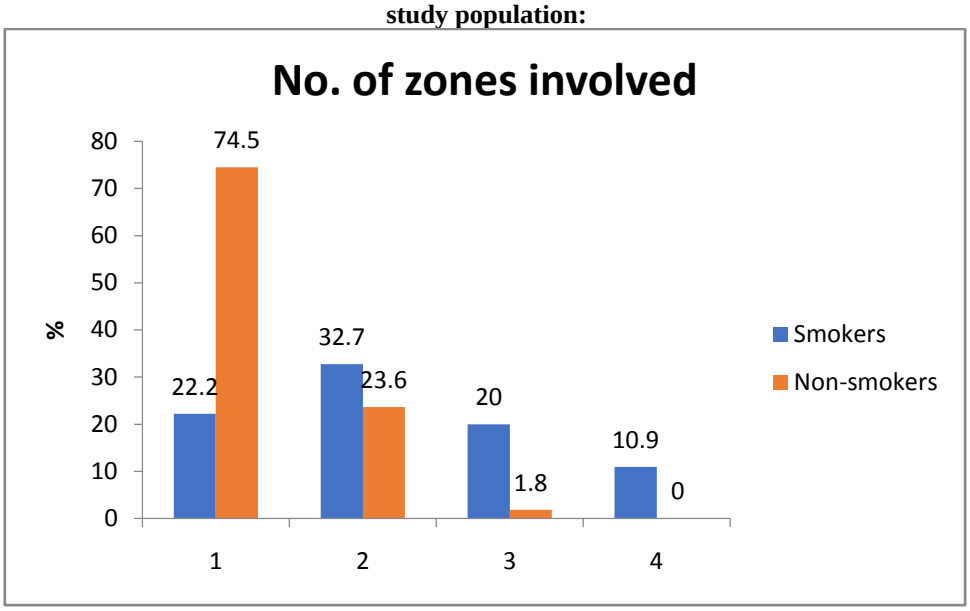

Table 15: Comparison of number of zones with spirometry and 6MWT among the study population (n=100):

Spirometry	Side	N	Mean	SD	P value
FVC	**1**	51	2.21	0.55	<0.0001
	2	31	2.11	0.45	
	3	12	1.56	0.49	
	4	6	1.27	0.35	
FEV1	**1**	51	1.71	0.46	<0.0001
	2	31	1.34	0.31	
	3	12	0.88	0.27	
	4	6	0.64	0.16	
FEV1-FVC	**1**	51	78.38	13.62	<0.0001
	2	31	64.18	9.22	
	3	12	57.42	10.96	
	4	6	51.32	5.47	
PEF	**1**	51	3.57	1.29	<0.0001
	2	31	2.61	0.99	
	3	12	1.68	0.96	
	4	6	1.17	0.42	
6 MWT	**1**	51	369.94	29.71	<0.0001
	2	31	338.77	24.75	
	3	12	284.67	32.57	
	4	6	263.67	32.29	

In present study, all the spirometry parameters such as FVC, FEV1, FEV1/FVC and PEF and 6 minute walk test distance was reduced among patients with multiple zone involvement when compared with patients having less number of zone involvement which was statistically significant (P value <0.05).

Chart 15A: Cluster bar chart showingcomparison of patients with number of zones involved and spirometry parameters among the study population:

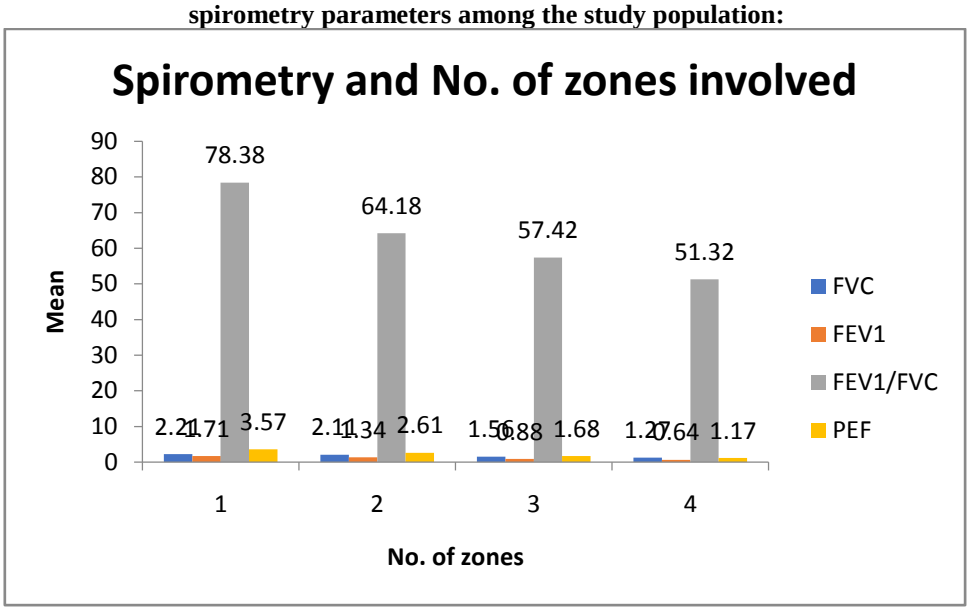

Chart 15B: Bar chart showing comparison ofpatients with number of zones involved and 6 minute walk test distance among the study population:

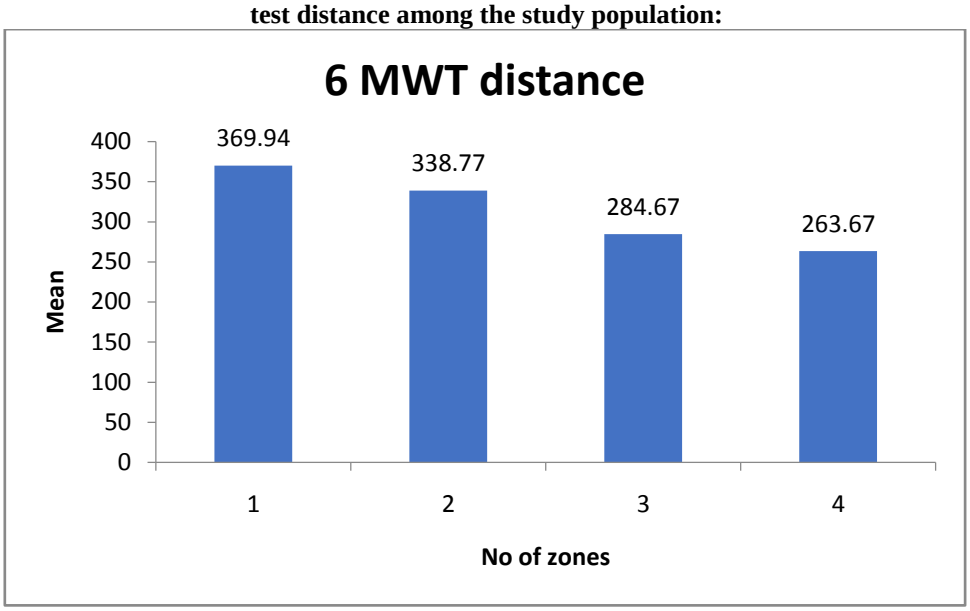

Table 16: Comparison of spirometry patterns of patients among the study population (n=100):

Patterns	Smokers (n=45)		Non-smokers (n=55)	
	N	%	N	%
Normal	1	2.2	20	36.4
Obstructive	14	31.1	16	29.1
Restrictive	3	6.7	13	23.6
Mixed	27	60.0	6	10.9
Total	45	100.0	55	100.0

In present study, majority of patients (60%) had mixed pattern followed by 31.1% of patients had obstructive patterns, 6.7% of patients had restrictive patterns and one patient had normal spirometry patterns among patients with smokers group. Majority of patients (36.4%) had normal patterns, 29.1% of patterns had obstructive patterns, 23.6% of patients had restrictive patterns and 10.9% of patients had mixed spirometry patterns among patients of non-smokers group.

Chart 16: Cluster bar chart showing comparison of spirometry patterns of patients among the study population:

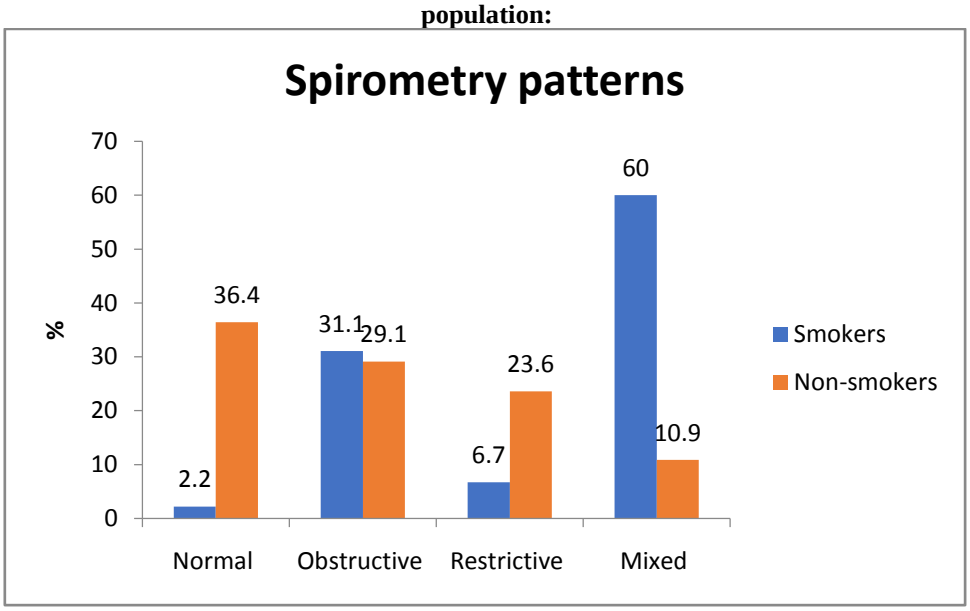

Table 17: Comparison of 6 minute walk test distance of patients among the study groups (n=100):

Parameter	Smokers (n=45)		Non-smokers (n=55)		P value
	Mean	SD	Mean	SD	
6MWT	313.73	40.73	368.16	30.19	<0.0001

In present study, the mean 6 minute walk test distance in patients of smokers was 313.73 ± 40.73 meters whereas the mean 6 minute walk test distance in patients of non-smokers was 368.16 ± 30.19 meters. There was statistically significant reduction in distance among patients with smokers when compared with patients of non-smokers group (P value <0.0001).

Chart 17: Bar chart showing comparison of 6 minute walk test distance of patients among the study groups:

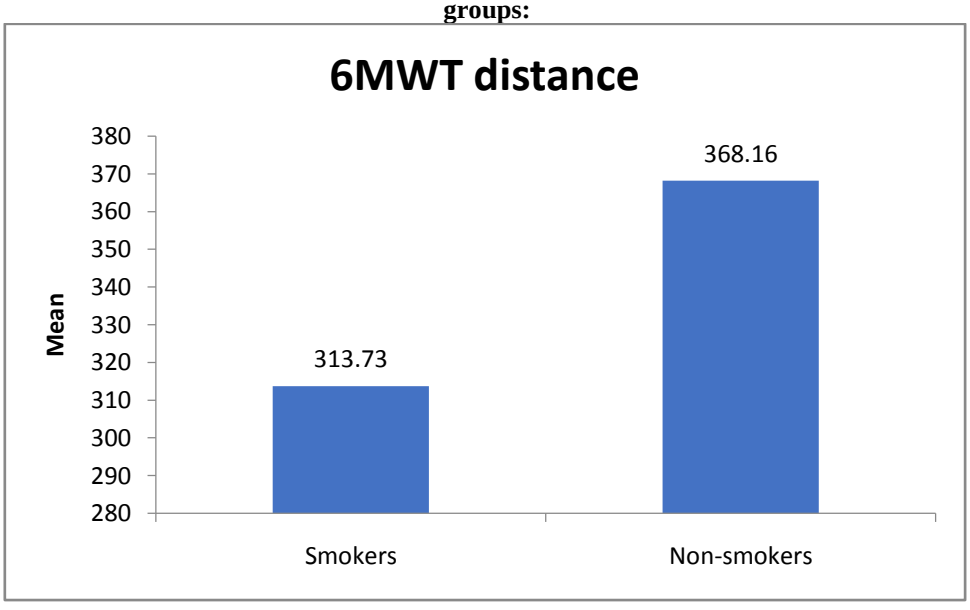

Table 18: Comparison of spirometry parameters and 6MWT distance with smoking index among patients of smokers group (n=45):

Spirometry		FVC	FEV1	FEV1/FVC	PEF	Distance
Smoking index	Correlation coefficient	-0.556	-0.676	-0.501	-0.469	-0.659
	P value	<0.0001	<0.0001	0.000	0.001	0.000

By using Spearman's correlation method, in present study all the spirometry findings such as FVC, FEV1, FEV1/FVC, PEF and 6 minute walk test distance had a statistically significant negative association with the smoking index (P value <0.05). Increase in smoking index causes decrease in spirometry parameters and 6 MWT distance.

V. Discussion

Tuberculosis which is a general major public health problem globally. Almost $1/4^{th}$ of the global burden is backed by India.

Tuberculosis is a extremely infectious disease that is affected byMycobacterium tuberculos*is* bacteria. Mycobacteriumtuberculosis extents easily from one person to another through the airborne spread of the droplet nuclei.

Even with satisfactory management with anti-tuberculosis drugs thecourse of curing consequences in a diverse squeal such as fibrosis, cavitation, bronchiectasis, bulla and calcification which might lead to several symptoms and changed pulmonary function. These patients typically present with symptoms such as breathlessness, cough with expectoration, wheeze, fever and vomiting of blood.

Collapsed or destroyed lung might be imagined as loss of lung volume of the exaggerated side, higher location of the hemi diaphragm, refutation of the hilum and dislodgment of the trachea and mediastinal structures.

Cavity is typically thin walled. It might comprise internal opacity with air crescent sign that is a common sign perceived in aspergilloma. Aspergillus fumigatusis the most common fungus to colonize the residue tuberculous cavities in the lung. It also produces hemoptysis.

Bronchiectasis is the perpetual dilatation and obliteration of the airways. It presents clinically as tenacious cough with the creation of copious amount of sputum, it may also present as recurrent episodes ofhemoptysis. Bronchiectasis also serves as a risk factor of pneumonia.

Currently, treatment is constructed on four drug regimens containing of Rifampicin, Isoniazid, Pyrazinamide and Ethambutol for drug-sensitive TB and patient precise management for Multidrug-resistant tuberculosis. Treatment accomplishment rates are overhead 95% in drug-sensitive TB.

In patients infested with M. tuberculosis, whether treated or untreated, a diversity of pulmonary and extra-pulmonary squeal and difficulties can happen which can be parenchymal, airway contribution or pleural. Structural variations lead to obstructive, restrictive, or mixed patterns of impaired pulmonary function.

Pulmonary impairment after tuberculosis (PIAT) refers to chronic pulmonary function loss that occurs in persons who have achieved microbiologic cure after pulmonary tuberculosis. Patients usually have pulmonary function abnormalities after completing treatment for pulmonary tuberculosis. Patients who are treated for tuberculosis are not routinely evaluated for these permanent changes. During treatment of tuberculosis performing repeat x-ray is considered not essential as per guidelines. Evaluation after a cure is only done for symptomatic patients and on suspicion of re-occurrence. Symptoms of pulmonary impairment are not present in all patients. Symptoms of pulmonary impairment generally do not occur in patients with chronic lung disease until FEV1 has fallen to 50% of normal values.Incidence of obstructive and restrictive lung disease post tuberculosis is not a well-established phenomenon and has a varied prevalence according to different studies.

Now a day, the functional deficiency because of several tuberculosissqueal is considered with tests such as the six minute walk test or the shuttle walk test. The pulmonary functional status is assessed with the help of spirometry. These tests assist to regulate the severity of the weakening and to evaluate the quality of life in such patients. These tests also aid in development of pulmonary rehabilitation for these patients which could raise the quality of life.

TB indicates poor ventilation and reduced gas exchange and ancomplete diminution in functional status.

The six-minute walk test more or less imitates the aptitude of the patients to achieve their daily life actions than the laboratory tests, and itis also well accepted by majority of the patients. Smoking has been demonstrated to cause a reduction in lung function by much number of mechanisms.

Smoking is a major risk factor that affects predominantly the respiratory and cardiovascular systems prominent to many respiratory ailments or it may exacerbate the respiratory symptoms.

There are numerous studies which concentrated on the pathophysiology, diagnosis,and management of Pulmonary TB but only scarce studies were prepared so far on the after effects of PT infection in lungs.

In the few studies that are being done on assessment of Lung functions in PTSqueal patients there are tangible proofs testifying that there is enduring functional worsening in these patients.

Several studies say that the obstructive pattern of lung damage is the commonest finding. But recent studies say that there is more number of patients with restrictive and mixed pattern of damage.

The particles of smoke dust affect the function of respiratoryairways by different mechanisms. Tar in the smoke produces an irritant effect on bronchial epithelium and destroys the cilia. Beedi smoke may be more harmful since beedi is an unrefined form of tobacco when compared to cigarettes.

This study is done to find if there is any significant relationship between the decreased lung function or exercise capacity due to smoking in addition to the effects caused by the tuberculosis squeal. This information may be used to explain the harm of smoking and to encourage the people to quit smoking.

A prospective cross sectional study was done among 100 patients satisfying inclusion and exclusion criteria attending outpatient department of pulmonology with history of pulmonary tuberculosis and completed treatment in KIMS, Amalapuram during the study period of 12 months after obtaining informed consent.

In present study, among 100 patients 55% of patients were non-smokers and 44% of patients were smokers.

Age:

In present study, majority of patients (40%) belong to age group of 60 to 69 years followed by 31.1% of patients belong to age group of 50 to 59 years, 13.3% of patients were of more than 70 years, 11.2% of patients belong to age group of 40 to 49 years and 4.4% of patients belong to age group of 30 to 39 years with mean age of 59.33 ± 10.07 years and range of 34 to 78 years among the smokers group. Majority of patients (29.1%) belong to age group of 50 to 59 years followed by 25.5% of patients belong to age group of 60 to 69 years, 20% of patients belong to age group of 40 to 49 years, 16.4% of patients belong to 30 to 39 years, 5.4% of patients belong to age group of more than 70 years and 3.6% of patients belong to age group of 20 to 29 years with mean age of 53.64 ± 12.38 years and range of 27 to 80 years among non-smokers group. In a study done by **Patil S et al**[83] among 500 symptomatic pulmonary tuberculosis patients the mean age was 42 ± 11 years whereas among 500 asymptomatic tuberculosis patients mean age was 48 ± 9 years. In a study done by **Mikhail C et al**[82] showed that among 214 patients showed majority of patients with pulmonary tuberculosis (27.6%) belong to age group of 40 to 49 years followed by 22.9% of patients belong to age group of 50 to 59 years, 21.5% of patients belong to age group of less than 40 years, 15% of patients belong to age group of 60 to 69 years and 13.1% of patients belong to age group of more than 70 years old with mean age of 51.1 year and range of 20 to 82 years. In a study done by **DhipuM et al**[80] showed that among 75 patients, majority of patients (25.3%) belong to age group of 50 to 59 years and 60 to 69 years followed by 22.7% of patients belong to age group of 40 to 49 years, 10.7% of patients belong to age more than 70 years and 30 to 39 years each and 5.3% of patients belong to age group of less than 30 years old. In a study done by **Sailaja et al**[81] showed that among 56 patients with PTB, majority of patients (28.6%) belong to age group of 21 to 30 years followed by 25% of patients belong to age group of 41 to 50 years, 19.6% of patients each belong to age group of 31 to 40 years and 51 to 60 years and 7.1% of patients belong to age group of 61 to 70 years old. In a study done by **Manji M et al**[74] showed that majority of patients (33.1%) of patients belong to age group of 18 to 30 years followed by 31.9% of patients belong to age 31 to 40 years, 19.2% of patients belong to age 41 to 50 years, 8.4% of patients belong to age 51 to 60 years and 7.4% of patients belong to age group of more than 60 years. In a study done by **SivaranjiniS et al**[75] showed that the mean age of male population of 57.7 ± 5.36 years and normal female population was 56.47 ± 5.23 years whereas male patients with PTB was 56.1 ± 5.1 years and female patients with PTB was 56.3 ± 5.26 years. In a study done by **Santra A et al**[79] showed that majority of patients belong to age group of 60 to 69 years (30.43%) followed by 24.64% of patients belong to age 50 to 59 years, 15.94% of patients belong to age 40 to 49 years, 13.04% of patients belong to age 30 to 39 years, 10.14% of patients belong to age 70 to 79 years and 5.79% of patients belong to age 20 to 29 years. In a study done by **Meyyappan D et al**[76] showed that majority of patients (66%) belong to age 50 to 60 years followed by 14% of patients belong to age 40 to 50years, 12% of patients belong to age of 60 to 70 years and 4% of patients each had 20 to 30 years and 30 to 40 years.

Gender:

In present study, among the smokers all the patients were males (100%) whereas among the non-smokers groups, 58.2% of patients were males and 41.8% of patients were females. In a study done by **Patil S et al**[83] showed that among symptomatic patients, 64% of patients were males and 36% of patients were females and among asymptomatic patients, 56% of patients were males and 44% of patients were females. In a study done by **Mikhail C et al**[82] showed that 61.7% of patients were males whereas 38.3% of patients were females. In a study done by **DhipuM et al**[80] showed that 68% of patients were males whereas 32% of patients were females. In a study done by **Sailaja et al**[81] showed that 67.9% of patients were males whereas 32.1% of patients were females. In a study done by **Manji M et al**[74] showed that 60.5% of patients were males whereas 39.5% of patients were females. In a study done by **SivaranjiniS et al**[75] showed that 50% of patients were males and 50% of patients were females. In a study done by **Santra A et al**[79] showed that 69.3% of patients were males whereas 30.7% of patients were females. In a study done by **Meyyappan D et al**[76] showed that 61.5% of patients were males whereas 38.5% of patients were females.

S no	Study	Males	Females
1	Present study	77%	23%
2	Mikhail C et al[82]	61.7%	38.3%
3	DhipuM et al[80]	68%	32%
4	Sailaja et al[81]	67.9%	32.1%

5	Manji M et al[74]	60.5%	39.5%
6	SivaranjiniS et al[75]	50%	50%
7	Santra A et al[79]	69.3%	30.7%
8	Meyyappan D et al[76]	61.5%	38.5%

Symptoms:

In present study, 97.8% of patients had cough, 84.4% of patients had sputum production, 4.4% of patients had chest pain, 95.6% of patients had breathlessness and 24.4% of patients had wheeze among smokers group. 80% of patients had cough, 58.2% of patients had sputum production, 49.1% of patients had breathlessness and 10.9% of patients had wheeze among non-smokers group. In a study done by **Patil S et al[83]** showed that 79% of patients had breathlessness, 48% of patients had cough and 39% of patients had expectoration. In a study done by **Santra A et al[79]** showed that 95.7% of patients had breathlessness, 89.9% of patients had cough and 75.4% of patients had production of sputum. In a study done by **DhipuM et al[80]** showed that majority of patients (84%) had difficulty in breathing followed by 81.3% of patients had cough and production of sputum.

Symptoms	Present study	Patil S et al[83]	Santra A et al[79]	DhipuM et al[80]
Cough	88%	48%	89.9%	81.3%
Expectoration	70%	39%	75.4%	
Chest pain	2%	-	-	
Dyspnea	70%	79%	95.7%	84%
Wheeze	17%	-	-	

Anthropometry:

In present study, the mean height of patients among smokers was 159.71 ± 6.29cm whereas among non-smokers was 156.91 ± 9.46cm. The mean weight of patients among smokers was 53.29 ± 8.46kg whereas among non-smokers was 50.29 ± 11.35kgs. Among the patients in smokers group, 71.1% of patients had normal body mass index, 22.2% of patients were under-weight and 6.7% of patients were over-weight with mean BMI of 20.62 ± 3.30kg/m2. Among the patients in non-smokers group, 45.5% of patients had normal body mass index, 40% of patients were under-weight and 14.5% of patients were over-weight with mean BMI of 20.45 ± 4.04kg/m2. In a study done by **Mikhail C et al[82]** showed that the mean BMI of patients was 23.9 ± 4.4kg/m2.

Smoking index:

In present study, majority of patients (80%) had smoking index of more than 300, 17.8% of patients had smoking index of 100 to 300 and 2.2% of patients had smoking index of less than 100 among the smokers group.

By using Spearman's correlation method, in present study all the spirometry findings such as FVC, FEV1, FEV1/FVC, PEF and 6 minute walk test distance had a statistically significant negative association with the smoking index (P value <0.05). Increase in smoking index causes decrease in spirometry parameters and 6 MWT distance.

In a study done by **Meyyappan D et al[76]** showed that among 200 patients, 62.3% of patients had smoking index of 100 to 300 followed by 35.8% of patients had smoking index of more than 300 and one patient had smoking index of less than 100. It was showed that no statistical significance found when exercise capacity and smoking index were compared among the patients.

ATT:

In present study, among 45 smokers patients 64.4% of patients belong to category II and 35.6% of patients belong to category II of ATT. Among the patients in non-smokers group, 81.8% of patients belong to category I and 18.2% of patients belong to category II of ATT. There statistical significance (P value <0.0001).

In present study, all the spirometry parameters such as FVC, FEV1, FEV1/FVC and PEF and 6 minute walk test distance was reduced among patients with multiple treatments when compared with CAT I patients which was statistically significant (P value <0.05).

In a study done by **FC Di Naso et al[86]** showed that functional evaluation of patients with post tuberculosis sequel resolved that lung function among patients of the group with multiple treatments (CAT II ATT) had significant decrease in FVC and FEV1 when compared with patients of group with single treatment (CAT I ATT). Among the patients with CAT II ATT, severe respiratory distress was found in 75% of cases when compared with 13.3% of cases of CAT I ATT group. Cases with CAT I ATT displayed radiologicalirregularities with slight involvement among 46.7% of patients and cases of CAT II ATT group had severe diminishing among 83.7% of patients as assessedby radiography. Mixed ventilatory defects were more prevalent in thegroup with multiple treatments.

In a study done by **LaxmanKumarSoni et al[87]** showed that impact of pulmonary tuberculosis sequel on functional status among patients with CAT II ATT displayed reduced FEV1%, FVC% and FEV1/FVC values. Cases among CAT II ATT also displayed much functional diminishing as the average distance walked in six

minute walk test was 78.21mts which was less when compared with patients of CAT I ATT. This recommends that multiple times treatedand cured TB patients suffer suggestively more clinical, radiological and functional idiosyncrasy when compared to single time treated patients.

Side involved:

In present study, 55.6% of smoking patients had unilateral lesions and 44.4% of smoking patients had bilateral lesion whereas 92.7% of non-smoking patients had unilateral lesions and 7.3% of non-smoking patients had bilateral lesions in chest X-ray.

In present study, all the spirometry parameters such as FVC, FEV1, FEV1/FVC and PEF and 6 minute walk test distance was reduced among patients with bilateral lesions when compared with patients with unilateral lesions which was statistically significant (P value <0.05).

Chest x-ray patterns:

In present study, 68.9% of patients had fibrosis, 15.6% of patients had collapse, 33.3% of patients had cavitation, 55.6% of patients had bronchiectasis and 64.4% of patients had combined x-ray patterns in the chest among patients of smokers group whereas 60% of patients had fibrosis, 14.5% of patients had cavitation, 41.8% of patients had bronchiectasis and 29.1% of patients had combined patterns in x-ray of chest among patients of non-smokers group.

In a study done by **Long R et al**[88] among 25 patients having post tuberculosis sequel, 36% of patients had emphysematous change, 40% of patients had bronchiectasis, 56% of patients had distortion of bronchi and 64% of patients had fibrosis as common x-ray findings. structural changes and diminishing of pulmonary function were the most common among patients with cavitary lesions when compare with patients of non-cavitary lesions.

In a study done by **Racilet et al**[89] showed that the residual radiology severity score was highest in patients of smoking history when compared with patients of non-smokers group. These findings were similar to present study findings.

Number of zones:

In present study among smoking group, 32.7% of patients had 2 zones involvement followed by 22.2% of patients had one zone involvement, 20% of patients had 3 zones involvement and 10.9% of patients had 4 zones involvement. Among the patients of non-smokers group, 74.5% of patients had one zone involvement, 23.6% of patients had 2 zones involvement and 1.8% of patients had 3 zones involvement. The p value was <0.0001 which was statistically significant.

In present study, all the spirometry parameters such as FVC, FEV1, FEV1/FVC and PEF and 6 minute walk test distance was reduced among patients with multiple zone involvement when compared with patients having less number of zone involvement which was statistically significant (P value <0.05).

Spirometry patterns:

In present study, majority of patients (60%) had mixed pattern followed by 31.1% of patients had obstructive patterns, 6.7% of patients had restrictive patterns and one patient had normal spirometry patterns among patients with smokers group. Majority of patients (36.4%) had normal patterns, 29.1% of patterns had obstructive patterns, 23.6% of patients had restrictive patterns and 10.9% of patients had mixed spirometry patterns among patients of non-smokers group.

Similar findings of present study were found in a study done by **Santra A et al**[79], where 27.5% of patients had obstructive pattern and 72.5% of patients had mixed spirometry patterns.

Also in a study done by **Nimit VK et al**[90] showed that 9% of patients had obstructive spirometry patterns, 37% of patients had restrictive patterns and 47% of patients had mixed spirometry patterns.

In a study done by **Neeta Singh et al**[91] showed that among 51 patients with multidrug resistance tuberculosis with completion of treatment displayed 78% of patients had persistent lung complaints, 98% of patients had residual lesions in chest X-ray and 96% of patients had showed ventilatory defects with 66% of aptients had mixed spirometry patterns, 19% of patients had restriction pattern and 11% of patients had obstructive spirometry patterns during post tuberculosis sequel.

In a study done by **Verma et al**[92] showed that among 92 patients with post tuberculosis sequel displayed 37 patients had restrictive spirometry patterns and 21 patients had mixed spirometry patterns.

In a study done by **Bhola Singh et al**[93] showed that 56.3% of patients had obstructive patterns of spirometry which was more common when compared with other types and restrictive patterns was observed among 10.42% of patients.

In a study done by **Manji et al**[74] showed that 42% of patients had obstructive pattern, 13% of patients had restrictive patterns and 19% of patients had mixed spirometry patterns.

In a study done by **Santhosh Kumar et al**[94] showed that in assessment of pulmonary diminishing done by spirometry during the course of post tuberculosis cases displayed that 45.1% of patients had obstructive spirometry patterns, 25.6% of patients had restrictive spirometry patterns and 29.3% of patients had mixed spirometry patterns.

In a study done by **Patil et al[83]** showed that spirometry evaluation of symptomatic patients with post tuberculosis showed that obstructive spirometry patterns was predominantly type and was recognised among 42% of patients, 14% of patients had mixed spirometry patterns and 46% of patients had normal patterns of spirometry.

Several earlier studies have exhibited a prominent association of airflowobstruction in post tubercular patients. In fact several studies have demonstratedthat tuberculosis serves as a sovereign risks factor for the progressof obstructive pattern in spirometry.The increased incidence of mixed or obstructive pattern ofventilator defect might be because of the dual effect on ventilation and perfusionby the tubercular bacilli. In formerly treated TB patients, the airwayswere structurally uncharacteristic which leads to reflex vasoconstriction andhypoxemia. Also, the bacilli directly source arteritis and thrombosis thatadapts perfusion. These patients also have other deviations likepleural thickening, fibrosis of the parenchyma, and atelectasis which helps as an additional factor for the predominant mixed pattern rather than thepattern of pure airflow obstruction.

S no	Study	Normal	Restrictive	Obstructive	Mixed
1	Present study	21%	16%	30%	33%
2	Sailaja et al[81]	-	16.1%	62.5%	21.4%
3	DhipuM et al[80]	-	68%	13.3%	18.7%
4	Meyyappan D et al[76]	19%	18%	23.5%	39.5%
5	Mikhail C et al[82]	52.4%	8.4%	34.6%	3.7%

Nicotine turns off the Tumour Necrosis Factor-alpha (TNF-α) that was frequently formed by the lung macrophages, which hints to amplified lung structural abnormalities .The mycobacterial antigens act as a cofactor along with smoking and other environmental factors such as biomass fuel or pollution, which leads to chronic airway inflammation that results in bronchial narrowing with or without destruction of the parenchyma. Smoking alters the normal host response and the chronic inflammation may produce parenchymal tissue destruction and it also impairs the normal repair and defense mechanisms leading to radiological squeal.

Due to the up regulation of different proteases like matrix metalloproteinase and defective protease control mechanism there is increased destruction of lung parenchyma that leads to airflow obstruction. Matrix metalloproteinase also leads to cicatrisationof lung tissue and fibrotic changes that were responsible for associated restrictive disorder.

In a study done by **Anup Banur et al[95]** on effects of smoking on spirometry showed that the values of forced expiratory volumes such as FVC, FEV1 and FEV1/FVC were reduced in beedi smokers. The values of forced expiratory volumes such as PEFR and MEF75 were also reduced in beedi smokers when compared with non-smoking patients.

In a study done by **Padmavathy KM[96]**and **Bano R et al[72]** showed similar findings of current study which displayed that the obstructive lung changes were the most common patterns among the patients with smoking history when compared with non-smoking patients.

6 minute walk test distance:

The 6MWT is an easy, feasible test that can be conducted withoutany special equipment even in the peripheral centers. There is no need forspecific training for the technicians.

Walking is a day to day simple activity and difficulty or decreasedwalking capacity implies the degree of impaired functional status of thepatient. 6MWT is a better index of the patient's ability to carry out thedaily activities.

The major indication for six minute walk test is to evaluate theeffectiveness of medical interventions in patients with lung disease. It is also used in measuring the one- time extent of the functional status of patients, and also serves as the predictor of morbidity and mortality.

In present study, the mean 6 minute walk test distance in patients of smokers was 313.73 ± 40.73 meters whereas the mean 6 minute walk test distance in patients of non-smokers was 368.16 ± 30.19 meters. There was statistically significant reduction in distance among patients with smokers when compared with patients of non-smokers group (P value <0.0001).

Similarly in a study done by **Sivaranjini et al[75]** showed that 6 minute walk test distance was statistically significant reduced among patients of smoking group when compared with patients of non-smoking group.

In a study done by **Lakshmansoni et al[97]** showed that there was significantly decreased lung function among patients with post tuberculosis sequel and the 6 minute walk test distance was low significantly among them. This finding was similar to current study results.

In a study done by **Mikhail C et al[82]** showed that there was statistically significant association between 6 minute walk test distance and the spirometry parameters with the symptoms which was similar to present study findings.

In a study done by **Marcos DP et al**[98] in assessing functional evaluation among cases with drug resistant tuberculosis exhibited low distance covered during 6 minute walk test among the patients after the treatment.

In a study done by **Meyyappan D et al**[76]showed that majority of patients (41.5%) had 6MWD of 50 to 75 followed by 39.5% of patients had 6MWD of 25 to 50, 17% of patients had 6MWD of less than 25 and 2% of patients had 6MWD of more than 75.

Throughout the six minute walk test the myocardial oxygen demand ofthe patient upsurges. In smokers there could be functional anemia because ofthe increased levels of carbon monoxide that leads to reducedcardiovascular retort to exercise. Smoking is also supposed to produceinjurious effects on peripheral muscles. All these effects result in reducedexercise tolerance in smokers. Smoking itself is accompanying with lowercardiovascular capacity and diminished cardiac response to exercise.

VI. Conclusion And Summary

In the patients after treatment of tuberculosis during the post-tuberculosis sequel, both the spirometric parameters and six minute walk distance test were statistically significantly decreased among the patients with habit of smoking when compared with patients of non-smokers group. During the period of post-tuberculosis cases presented with sequel all the parameters of spirometry and six minute walk test were used in evaluation of functional status and superiority of life among the patients. These tests might help in preparation for restoration to reduce the clinical features and expand the functional status among the patients. Thus, the significance of smoking termination should be accentuated among all the cases with diagnosis of tuberculosis.