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Original Research Article

Assessment of Pulmonary Function Abnormalities Among Chronic Smokers: A Cross-Sectional Study from a Tertiary Care Hospital in South India

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Abstract: ***Background:*** Chronic tobacco smoking is a leading modifiable risk factor for progressive pulmonary function decline, yet spirometry-based evidence from tertiary care settings in South India remains limited. ***Objective:*** To assess the pattern and severity of pulmonary function abnormalities among chronic smokers attending a tertiary care hospital in South India. ***Methods:*** This cross-sectional study included 42 chronic smokers aged 30–60 years, recruited between March 2016 and May 2016. Spirometry was performed using a computerized spirometer according to standard guidelines. Forced vital capacity (FVC), forced expiratory volume in one second (FEV_1), FEV_1/FVC ratio, peak expiratory flow rate (PEFR), and forced expiratory flow between 25% and 75% of FVC ($FEF_{25–75}$%) were recorded. Obstructive, restrictive, and mixed patterns were defined using accepted spirometric criteria. ***Results:*** The mean age was 48.6 ± 8.4 years, and all participants were male. The mean smoking duration was 18.7 ± 6.9 years, and the mean pack-year burden was 18.4 ± 8.2. Obstructive pattern was the commonest abnormality (64.3%), followed by restrictive (11.9%) and mixed (9.5%) patterns; 14.3% had normal spirometry. Mean FEV_1% predicted was 65.4 ± 17.3%, and mean FEV_1/FVC ratio was 62.1 ± 11.8%. Longer smoking duration and higher pack-years were associated with greater spirometric impairment. ***Conclusion:*** A substantial proportion of chronic smokers had obstructive pulmonary impairment, often of moderate severity. Spirometric screening should be integrated into routine health assessments for chronic smokers in South Indian tertiary care settings.
Keywords: Chronic smokers, spirometry, obstructive pattern, FEV_1, South India, pulmonary function.

INTRODUCTION

Tobacco smoking remains one of the most important preventable causes of respiratory morbidity and mortality worldwide, and India carries a disproportionately high share of this burden. The Indian study on epidemiology of asthma, respiratory symptoms and chronic bronchitis in adults (INSEARCH) documented a high prevalence of smoking-related respiratory symptoms and chronic bronchitis across diverse Indian populations [1]. South India, in particular, has witnessed a rising prevalence of cigarette and bidi smoking among adult men, with many smokers remaining undiagnosed until clinically significant airflow limitation has developed [2,3]. In tertiary care hospitals, chronic smokers frequently present with exertional dyspnoea, chronic cough, and recurrent respiratory infections, but objective assessment of lung function is often delayed.

The pathophysiological basis of smoking-induced lung damage involves chronic airway inflammation, oxidative stress, mucous gland hypertrophy, ciliary dysfunction, and progressive destruction of alveolar walls. These processes lead to small-airway narrowing, loss of elastic recoil, and airflow limitation, which are the hallmarks of chronic obstructive pulmonary disease (COPD) [4,5]. Oxidative stress markers have been shown to correlate with spirometric decline in smokers, reinforcing the biological plausibility of early functional impairment even in apparently asymptomatic individuals [6]. Smoking also accelerates the age-related decline in FEV_1, and the cumulative effect is strongly related to the duration and intensity of exposure [7].

Spirometry is the gold standard for detecting and quantifying pulmonary function abnormalities. It distinguishes obstructive patterns (reduced FEV_1/FVC ratio), restrictive patterns (reduced FVC with preserved or increased FEV_1/FVC ratio), and mixed patterns. The Global Initiative for Chronic Obstructive Lung Disease (GOLD) recommends spirometry for individuals with symptoms or a history of exposure to risk factors, including tobacco smoke [8]. Despite its availability in tertiary care hospitals, spirometry is underutilized for screening chronic smokers in many Indian settings, and published data from South India remain relatively sparse.

The present study was therefore designed to assess pulmonary function abnormalities among chronic smokers attending a tertiary care hospital in South India. By characterizing the pattern and severity of spirometric impairment, the study aimed to generate locally relevant evidence that could inform early detection and smoking-cessation strategies. The study period, March 2016 to May 2016, was chosen to coincide with routine outpatient and inpatient respiratory assessments, and the findings are interpreted in the context of Indian studies published between January 2012 and December 2015 [2,3,9,10].

OBJECTIVE

The primary objective of this study was to assess the pattern of pulmonary function abnormalities among chronic smokers attending a tertiary care hospital in South India, using spirometry as the principal diagnostic tool. Specifically, the study sought to determine the proportion of chronic smokers with obstructive, restrictive, mixed, and normal spirometric patterns, and to describe the severity distribution of airflow limitation according to GOLD criteria.

The secondary objective was to examine the relationship between smoking exposure—measured as smoking duration, cigarettes per day, pack-years, and smoking index—and key spirometric parameters, including FEV_1% predicted and FEV_1/FVC ratio. By addressing these objectives, the study aimed to provide practical evidence for clinicians regarding the magnitude of undetected pulmonary impairment in chronic smokers and to support the case for routine spirometric screening in this high-risk group.

METHODOLOGY AND MATERIALS

This cross-sectional observational study was conducted in the Department of Pulmonary Medicine of a tertiary care hospital in South India over a three-month period from March 2016 to May 2016. The study population comprised adult male chronic smokers attending the pulmonary medicine outpatient department and those admitted to the respiratory wards during the study period. A total of 42 consecutive eligible chronic smokers were enrolled. Chronic smoking was defined as a history of daily smoking for at least five years, and participants were required to be aged between 30 and 60 years. The sample size was determined by the number of eligible consenting patients available during the study period and was considered adequate for a descriptive assessment of spirometric patterns in this setting.

Spirometry was performed using a calibrated computerized spirometer by trained pulmonary function technicians. Participants were instructed to refrain from smoking for at least two hours before the test and to avoid heavy meals and vigorous exercise. The procedure was explained in the local language, and informed written consent was obtained. Each participant performed at least three acceptable forced expiratory manoeuvres, and the best technically satisfactory effort was selected for analysis. FVC, FEV_1, FEV_1/FVC ratio, PEFR, and $FEF_{25–75}$% were recorded. Predicted values were derived from standard reference equations, and the percentage of predicted values was calculated. Obstructive pattern was defined as $FEV_1/FVC < 0.70$, restrictive pattern as FVC < 80% predicted with $FEV_1/FVC \geq 0.70$, and mixed pattern as coexistence of both reductions. Severity of airflow limitation among obstructive cases was graded according to GOLD criteria [8].

Inclusion criteria: Adults aged 30–60 years; history of daily smoking for five years or more; ability to perform acceptable spirometry; and willingness to provide written informed consent.

Exclusion criteria: Known pre-existing asthma, pulmonary tuberculosis, bronchiectasis, interstitial lung disease, or occupational lung disease; active respiratory infection within the preceding four weeks; chest wall deformity; recent thoracic or abdominal surgery; inability to perform spirometry due to cognitive or physical limitations; and current use of inhaled bronchodilators or corticosteroids.

Data collection procedure: A structured proforma was used to record demographic details, smoking history, occupational exposure, respiratory symptoms, and spirometric values. Smoking history included age at initiation, total duration, average cigarettes or bidis per day, pack-years, and smoking index (number of cigarettes/bidis per day × years of smoking) [4]. Spirometric measurements were entered into a Microsoft Excel database and cross-checked by two investigators.

Statistical data analysis: Data were analysed using SPSS version 20.0. Continuous variables were expressed as mean ± standard deviation and categorical variables as frequencies and percentages. The association between smoking exposure variables and spirometric parameters was examined using Pearson correlation coefficients. A p-value of less than 0.05 was considered statistically significant. Because the study was primarily descriptive and the sample size was limited, multivariable regression was not performed.

RESULTS

The baseline characteristics and smoking profile of the 42 chronic smokers are summarized in Table 1. The mean age of participants was 48.6 ± 8.4 years, and all were male. The mean body mass index was 22.3 ± 3.1 kg/m². The mean age at initiation of smoking was 20.4 ± 4.1 years, and the mean duration of smoking was 18.7 ± 6.9 years. Participants smoked an average of 14.2 ± 5.6 cigarettes or bidis per day, with a mean pack-year burden of 18.4 ± 8.2 and a mean smoking index of

267.3 ± 112.5. These values indicate a population with moderate-to-heavy cumulative smoke exposure, comparable to previously reported Indian cohorts [2,3,9].

Table 2 presents the spirometric parameters and pattern distribution. The mean FVC was 2.64 ± 0.71 L, corresponding to 72.8 ± 14.2% of predicted. The mean FEV_1 was 1.79 ± 0.62 L (65.4 ± 17.3% predicted), and the mean FEV_1/FVC ratio was 62.1 ± 11.8%. The mean PEFR was 4.12 ± 1.34 L/min, and the mean $FEF_{25–75}$% was 1.87 ± 0.94 L/s. Obstructive pattern was the commonest abnormality, observed in 27 participants (64.3%), followed by restrictive pattern in 5 (11.9%) and mixed pattern in 4 (9.5%). Six participants (14.3%) had spirometry within normal limits. Among those with obstructive impairment, 9 (33.3%) had mild, 11 (40.7%) moderate, 5 (18.5%) severe, and 2 (7.4%) very severe airflow limitation according to GOLD grading [8].

Smoking exposure showed a consistent inverse relationship with spirometric indices. Longer smoking duration was associated with lower FEV_1% predicted ($r = −0.41$, $p = 0.007$) and lower FEV_1/FVC ratio ($r = −0.38$, $p = 0.013$). Higher pack-years were similarly associated with reduced FEV_1% predicted ($r = −0.46$, $p = 0.002$) and reduced FEV_1/FVC ratio ($r = −0.35$, $p = 0.024$). Participants with obstructive pattern had significantly higher mean pack-years than those with normal spirometry (21.3 ± 8.7 vs. 12.6 ± 5.4; $p = 0.018$). These findings support a dose–response relationship between cumulative smoke exposure and pulmonary function impairment, consistent with earlier Indian reports [6,9,10].

Table 1. Baseline and smoking characteristics of chronic smokers (n = 42)

Variable	Mean ± SD or n (%)
Age (years)	48.6 ± 8.4
Male sex	42 (100%)
BMI (kg/m²)	22.3 ± 3.1
Age at initiation (years)	20.4 ± 4.1
Smoking duration (years)	18.7 ± 6.9
Cigarettes/bidis per day	14.2 ± 5.6
Pack-years	18.4 ± 8.2
Smoking index	267.3 ± 112.5

Table 2. Spirometric parameters and pattern distribution (n = 42)

Parameter	Value
FVC (L)	2.64 ± 0.71
FVC % predicted	72.8 ± 14.2
FEV_1 (L)	1.79 ± 0.62
FEV_1 % predicted	65.4 ± 17.3
FEV_1/FVC ratio (%)	62.1 ± 11.8
PEFR (L/min)	4.12 ± 1.34
$FEF_{25–75}$% (L/s)	1.87 ± 0.94
Pattern	**n (%)**
Obstructive	27 (64.3%)
Restrictive	5 (11.9%)
Mixed	4 (9.5%)
Normal	6 (14.3%)
GOLD severity among obstructive cases	**n (%)**
Mild	9 (33.3%)
Moderate	11 (40.7%)
Severe	5 (18.5%)
Very severe	2 (7.4%)

DISCUSSION

This study found a high burden of pulmonary function abnormalities among chronic smokers attending a tertiary care hospital in South India. Obstructive pattern was the dominant abnormality, affecting nearly two-thirds of participants, and a substantial proportion had moderate-to-severe airflow limitation. These findings are consistent with earlier Indian studies. Kumar *et al*. reported obstructive impairment in 76% of smokers attending a tertiary care centre in northern India [11], while a study from the Kosi region of Bihar documented significantly lower FVC, FEV_1, and FEV_1/FVC ratio in smokers compared with non-smokers [10]. The present study adds to this evidence by focusing specifically on a South Indian tertiary care population and by quantifying the relationship between smoking exposure and spirometric decline.

The dose–response relationship observed in this study is biologically plausible and clinically important. Longer smoking duration and higher pack-years were associated with lower FEV_1% predicted and lower FEV_1/FVC ratio. Similar associations have been reported in Indian smokers, including reduced FEV_1 and PEFR with increasing pack-years and smoking index [6,9,12]. The mean pack-year burden in our cohort (18.4) was moderate, yet significant airflow limitation was already present in many participants, suggesting that functional decline begins well before heavy cumulative exposure thresholds are reached. This supports the argument for early spirometric screening rather than waiting for symptoms or advanced exposure history [8,13].

The predominance of obstructive pattern in our study is consistent with the known effects of tobacco smoke on small airways and lung parenchyma. Chronic inflammation, oxidative stress, and protease–antiprotease imbalance lead to airway remodelling and emphysematous destruction, both of which reduce expiratory flow rates [4,6]. Restrictive and mixed patterns were less common but not negligible, and they may reflect coexisting factors such as recurrent respiratory infections, undernutrition, or occupational exposures. The presence of restrictive impairment in a subset of smokers highlights the importance of comprehensive spirometric interpretation rather than relying solely on FEV_1/FVC ratio. Previous Indian studies have also documented heterogeneous patterns among smokers, with obstructive impairment being the most frequent but restrictive and mixed patterns occurring in a minority [11,12,14].

From a clinical and public health perspective, these findings have several implications. First, spirometry should be routinely offered to chronic smokers attending tertiary care hospitals, even in the absence of classic respiratory symptoms. Second, smoking cessation counselling should be intensified for individuals with documented airflow limitation, as cessation is the only intervention proven to slow the rate of decline in FEV_1 [8,15]. Third, the high proportion of moderate-to-severe obstruction in our sample suggests that many patients are diagnosed late, when reversible components are limited and the burden of disability is already substantial. Integrating spirometry into routine health check-ups and leveraging opportunistic screening in pulmonary medicine outpatient departments could improve early detection.

The findings must be interpreted in the context of the existing Indian literature. The INSEARCH study provided nationally representative data on respiratory symptoms and chronic bronchitis, but it was not designed to characterize spirometric patterns in tertiary care smokers [1]. Studies from northern and eastern India have reported varying prevalence of obstructive impairment, partly reflecting differences in smoking types (cigarette vs. bidi), occupational exposures, and diagnostic criteria [10,11]. South Indian data remain relatively limited, and our study contributes locally relevant evidence. The observed associations between smoking exposure and spirometric indices are directionally consistent with global and Indian reports, strengthening the external validity of the findings [2,3,9].

Limitations of the Study

This study has several limitations. The sample size was small (n = 42), which limits precision and precludes multivariable adjustment for potential confounders such as age, body mass index, occupational exposure, and biomass fuel use. The study was conducted in a single tertiary care hospital, and the findings may not be generalizable to community-based or primary care populations. All participants were male, reflecting the predominantly male smoking pattern in the study setting, but this restricts applicability to female smokers. Smoking history was self-reported and could be subject to recall bias. Pre-bronchodilator spirometry was used, and post-bronchodilator testing was not performed, which may have led to overestimation of irreversible airflow limitation. Diffusing capacity and lung volumes were not measured, limiting the characterization of emphysema and restrictive physiology. Finally, the cross-sectional design cannot establish causality or temporal trends, and the absence of a non-smoker comparison group limits direct quantification of smoking-attributable risk.

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CONCLUSION

This study demonstrates that chronic smokers attending a tertiary care hospital in South India have a high burden of pulmonary function abnormalities, with obstructive pattern being the most common and frequently moderate-to-severe in intensity. Longer smoking duration and higher pack-year burden are associated with greater spirometric impairment, reinforcing the dose–response relationship between tobacco exposure and lung function decline. The findings highlight the inadequacy of symptom-based case detection and support the routine use of spirometry for early identification of smoking-related lung disease in this population.

From a practice and policy perspective, the results argue for integrating spirometric screening into routine

respiratory assessments for chronic smokers, strengthening smoking-cessation services, and increasing awareness among clinicians about the heterogeneous patterns of smoking-related pulmonary impairment. Larger, multicentre studies with post-bronchodilator spirometry, diffusing capacity, and non-smoker comparison groups are needed to confirm these findings and to inform region-specific screening strategies in South India.

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