ORIGINAL RESEARCH

Pulmonary Function and Anatomical Variations in Smokers vs. Non-Smokers: An observational study

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ABSTRACT

Background: Smoking is a well-established risk factor for pulmonary disease, yet the specific differences in pulmonary function and anatomical variations between smokers and non-smokers require further elucidation. **Objectives:** This study aims to compare pulmonary function and anatomical lung variations in smokers versus non-smokers. **Methods:** An observational study was conducted with 100 participants, divided equally into smokers (n=50) and non-smokers (n=50). Demographic data were collected, and pulmonary function tests (PFTs) were performed, including Forced Vital Capacity (FVC), Forced Expiratory Volume in 1 second (FEV1), FEV1/FVC ratio, and Peak Expiratory Flow (PEF). Chest CT scans assessed anatomical variations, such as emphysema, bronchial wall thickening, and pulmonary nodules. **Results:** Smokers had a mean age of 45.3 years (±10.2) and a mean pack-year history of 20.4 (±8.7). PFTs showed significantly lower mean FVC (3.4 ± 0.6 L vs. 4.2 ± 0.5 L, $p < 0.001$), FEV1 (2.7 ± 0.5 L vs. 3.9 ± 0.4 L, $p < 0.001$), and PEF (380.2 ± 50.1 L/min vs. 460.7 ± 45.3 L/min, $p < 0.001$) in smokers compared to non-smokers. The FEV1/FVC ratio was also lower in smokers (79.4%± 5.3 vs. 92.8% ± 4.7, $p < 0.001$). Anatomical differences revealed that smokers had higher incidences of emphysema (70% vs. 10%, $p < 0.001$), bronchial wall thickening (56% vs. 14%, $p < 0.001$), and pulmonary nodules (30% vs. 6%, $p < 0.001$). **Conclusion:** The study demonstrates significant adverse effects of smoking on pulmonary function and lung anatomy. These findings underscore the critical need for smoking cessation programs to reduce smoking-related morbidity.

Keywords: Pulmonary function, Smokers, Non-smokers, Emphysema, Bronchial wall thickening, Pulmonary nodules.

INTRODUCTION

Smoking remains one of the leading causes of preventable disease and death worldwide. Despite extensive public health efforts to reduce smoking rates, it continues to pose significant health risks, particularly to pulmonary function and lung anatomy[1,2]. The adverse effects of smoking on respiratory health are well-documented, with numerous studies highlighting its role in the development of chronic obstructive pulmonary disease (COPD), lung cancer, and other respiratory conditions[3].

Pulmonary function tests (PFTs) are essential tools for evaluating lung function and diagnosing respiratory disorders. Key parameters measured in PFTs include Forced Vital Capacity (FVC), Forced Expiratory Volume in 1 second (FEV1), FEV1/FVC ratio, and Peak Expiratory Flow (PEF)[4]. These tests provide critical insights into the functional impairments caused by smoking[5]. Additionally, advances in imaging technology, such as chest CT scans, have enabled detailed assessments of anatomical variations in the lungs, such as emphysema, bronchial wall thickening, and pulmonary nodules, which are frequently associated with smoking[6,7].

This study aims to provide a comprehensive comparison of pulmonary function and anatomical lung variations between smokers and non-smokers. By elucidating the specific differences in lung function and structure, we seek to underscore the significant impact of smoking on respiratory health. Understanding these differences is crucial for

informing public health strategies, guiding clinical practice, and reinforcing the importance of smoking cessation programs.

METHODOLOGY

Study Design and Setting

This observational study was conducted at Sri Venkateswara Medical College, Tirupati, over a period from September 2022 to February 2023. The study aimed to compare pulmonary function and anatomical lung variations between smokers and non-smokers.

Participants

A total of 100 participants were recruited for the study, with 50 smokers and 50 non-smokers. Participants were selected using a convenience sampling method. Inclusion criteria for smokers were individuals with a history of smoking at least 10 cigarettes per day for a minimum of 10 years. Non-smokers were defined as individuals who had never smoked. Exclusion criteria included participants with a history of chronic respiratory diseases (other than those directly related to smoking in the smoker group), recent respiratory infections, and those with significant occupational exposure to respiratory irritants.

Data Collection

Demographic and Baseline Data: Demographic information, including age, gender, and Body Mass Index (BMI), was collected for all participants. For smokers, additional data on smoking history, including pack-years, were recorded.

Pulmonary Function Tests (PFTs): Pulmonary function was assessed using standardized spirometry. The primary parameters measured included:

Forced Vital Capacity (FVC)

Forced Expiratory Volume in 1 second (FEV1)

FEV1/FVC ratio

Peak Expiratory Flow (PEF)

All tests were performed following the American Thoracic Society (ATS) guidelines to ensure accuracy and reproducibility.

Chest CT Scans: High-resolution chest computed tomography (CT) scans were performed on all participants to assess anatomical variations. Key findings evaluated included the presence of emphysema, bronchial wall thickening, and pulmonary nodules. Radiologists blinded to the participants' smoking status reviewed all CT scans to minimize bias.

Statistical Analysis

Data were analyzed using SPSS version 26.0. Descriptive statistics were used to summarize demographic and baseline characteristics. Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. The independent t-test was used to compare mean values of pulmonary function parameters between smokers and non-smokers. The chi-square test was applied to compare the prevalence of anatomical variations. A p-value of < 0.05 was considered statistically significant.

Ethical Considerations

The study was conducted in accordance with ethical guidelines and standards. Informed consent was obtained from all participants. The study protocol was reviewed and necessary prior permissions taken from concerned authorities.

RESULTS

Demographic and Baseline Characteristics

The study included 100 participants, equally divided into two groups: smokers (n=50) and non-smokers (n=50). The mean age of the smokers was 45.3 years (±10.2), while the non-smokers had a mean age of 44.7 years (±9.8). The gender distribution among smokers was 32 males and 18 females, compared to 30 males and 20 females in the non-smoker group. The average Body Mass Index (BMI) was 24.6 kg/m² (±3.4) for smokers and 23.9 kg/m² (±3.1) for non-smokers. Smokers had an average smoking history of 20.4 pack-years (±8.7)(Table No:1).

Pulmonary Function Tests

Pulmonary function tests revealed significant differences between smokers and non-smokers. Smokers exhibited a mean Forced Vital Capacity (FVC) of 3.4 liters (±0.6), significantly lower than the 4.2 liters (±0.5) observed in non-smokers ($p < 0.001$). Similarly, the Forced Expiratory Volume in 1 second (FEV1) was markedly reduced in smokers, with a mean value of 2.7 liters (±0.5) compared to 3.9 liters (±0.4) in non-smokers ($p < 0.001$). The FEV1/FVC ratio was also significantly lower in smokers (79.4% ± 5.3) than in non-smokers (92.8% ± 4.7) ($p < 0.001$). Peak Expiratory Flow (PEF) was reduced in smokers, with a mean of 380.2 liters per minute (±50.1) versus 460.7 liters per minute (±45.3) in non-smokers ($p < 0.001$)(Table No:2).

Anatomical Variations

Chest CT scans indicated significant anatomical differences between the two groups. Emphysema was present in 70% of smokers, compared to only 10% of non-smokers ($p < 0.001$). Bronchial wall thickening was observed in 56% of smokers, significantly higher than the 14% in non-smokers ($p < 0.001$). Pulmonary nodules were detected in 30% of smokers, while only 6% of non-smokers exhibited nodules ($p < 0.001$)(Table No:3).

Table No: 1 Demographic and Baseline Characteristics

Characteristic	Smokers (n=50)	Non-Smokers (n=50)
Mean Age (years)	45.3 ± 10.2	44.7 ± 9.8
Gender (M/F)	32/18	30/20
BMI (kg/m²)	24.6 ± 3.4	23.9 ± 3.1
Pack-Years (Smokers)	20.4 ± 8.7	N/A

Table No: 2 Pulmonary Function Tests

Parameter	Smokers (n=50)	Non-Smokers (n=50)	p-value
FVC (L)	3.4 ± 0.6	4.2 ± 0.5	< 0.001
FEV1 (L)	2.7 ± 0.5	3.9 ± 0.4	< 0.001
FEV1/FVC (%)	79.4 ± 5.3	92.8 ± 4.7	< 0.001
PEF (L/min)	380.2 ± 50.1	460.7 ± 45.3	< 0.001

Table No: 3 Anatomical Variations

Anatomical Variation	Smokers (n=50)	Non-Smokers (n=50)	p-value
Emphysema	35 (70%)	5 (10%)	< 0.001
Bronchial Wall Thickening	28 (56%)	7 (14%)	< 0.001
Nodules	15 (30%)	3 (6%)	< 0.001

DISCUSSION

This study aimed to compare pulmonary function and anatomical lung variations between smokers and non-smokers, revealing significant differences attributable to smoking. Our findings underscore the detrimental impact of smoking on respiratory health, providing valuable insights for clinicians and public health policymakers.

Pulmonary Function

The results of the pulmonary function tests (PFTs) demonstrate that smokers have significantly reduced lung function compared to non-smokers. Smokers exhibited lower Forced Vital Capacity (FVC), Forced Expiratory Volume in 1 second (FEV1), and Peak Expiratory Flow (PEF), as well as a lower FEV1/FVC ratio. These findings are consistent with previous studies indicating that smoking leads to obstructive airway disease and impaired lung function[8] . The reduced FEV1/FVC ratio in smokers highlights the obstructive nature of the lung damage caused by smoking, which can progress to chronic obstructive pulmonary disease[9] (COPD).

Anatomical Variations

High-resolution chest CT scans revealed significant anatomical differences between smokers and non-smokers. Emphysema, bronchial wall thickening, and pulmonary nodules were markedly more prevalent in smokers[10]. These anatomical changes are characteristic of smoking-related lung damage and are associated with increased morbidity and mortality . The high prevalence of emphysema among smokers (70%) compared to non-smokers (10%) underscores the severe impact of smoking on lung tissue integrity and function[11].

Implications for Public Health

The findings of this study have important public health implications. The significant differences in both pulmonary function and anatomical lung characteristics between smokers and non-smokers highlight the urgent need for effective smoking cessation programs. Public health strategies should focus on reducing smoking initiation, promoting cessation, and providing support for individuals attempting to quit. Additionally, raising awareness about the specific harms of smoking, including its impact on lung function and structure, can motivate individuals to avoid or cease smoking[12].

Clinical Relevance

For clinicians, the study underscores the importance of regular pulmonary function testing and imaging for smokers. Early detection of functional impairments and anatomical changes can facilitate timely interventions to mitigate the progression of smoking-related diseases. Moreover, the study supports the use of comprehensive smoking cessation interventions as a critical component of respiratory healthcare.

Limitations

The study has several limitations. The sample size, while adequate for detecting significant differences, may limit the generalizability of the findings. The use of convenience sampling may introduce selection bias. Additionally, the cross-sectional design of the study precludes the assessment of causality. Longitudinal studies are needed to further elucidate the progression of smoking-related lung damage over time.

CONCLUSION

This study provides compelling evidence of the adverse effects of smoking on pulmonary function and lung anatomy. The significant differences observed between smokers and non-smokers highlight the

critical need for continued public health efforts to reduce smoking prevalence and its associated health risks. Future research should focus on longitudinal assessments and interventions aimed at mitigating the impact of smoking on respiratory health.

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