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ORIGINAL ARTICLE

PULMONARY FUNCTION TESTS IN SMOKERS VS NON-SMOKERS: A COMPARATIVE EVALUATION OF RESPIRATORY PERFORMANCE

Rifah Afreen[1],

Student from group 132, Samarkand State Medical University[1]

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Abstract

Smoking remains one of the leading preventable causes of chronic respiratory disease and premature mortality worldwide. Long-term exposure to tobacco smoke causes progressive structural and functional changes in the respiratory system, resulting in airflow limitation, impaired gas exchange, and decreased pulmonary reserve. Pulmonary function tests (PFTs) provide a reliable, non-invasive method for assessing respiratory performance and detecting early functional impairment before the onset of clinical symptoms. This review compares pulmonary function parameters between smokers and non-smokers, emphasizing the physiological effects of tobacco smoke, the diagnostic value of spirometry, and the clinical importance of early screening. Current evidence demonstrates that smokers exhibit significantly lower forced expiratory volumes, reduced expiratory flow rates, and impaired ventilatory capacity compared with healthy non-smokers. Early identification of respiratory dysfunction through pulmonary function testing can facilitate smoking cessation interventions and reduce the risk of chronic obstructive pulmonary disease and other smoking-related pulmonary disorders.

Keywords: pulmonary function test, spirometry, smoking, lung function, respiratory physiology, chronic obstructive pulmonary disease, forced vital capacity, FEV1, tobacco exposure.

1. Introduction

Tobacco smoking continues to represent one of the greatest public health challenges worldwide. Cigarette smoke contains more than 7,000 chemical substances, including nicotine, carbon monoxide, tar, oxidizing agents, heavy metals, and numerous carcinogenic compounds. Continuous inhalation of these toxic substances produces chronic inflammation, oxidative stress, epithelial injury, mucus hypersecretion, destruction of alveolar walls, and progressive remodeling of the airways. These pathological alterations gradually impair pulmonary function, often many years before respiratory symptoms become clinically apparent.

The respiratory system plays a critical role in maintaining oxygen delivery and carbon dioxide elimination. Efficient pulmonary function depends on normal airway patency, elastic lung tissue, adequate respiratory muscle strength, intact alveolar-capillary membranes, and coordinated neural control of ventilation. Smoking adversely affects each of these physiological components through multiple pathological mechanisms.

Initially, cigarette smoke causes irritation of the bronchial epithelium and stimulates inflammatory cell infiltration. Activated neutrophils, macrophages, and lymphocytes release proteolytic enzymes and inflammatory cytokines that damage airway tissues and accelerate destruction of elastic fibers. Chronic inflammation also increases mucus production while reducing ciliary function, resulting in impaired mucociliary clearance and persistent airway obstruction.

Oxidative stress is another important mechanism contributing to smoking-induced lung injury. Reactive oxygen species generated by tobacco smoke damage cellular proteins, lipids, and DNA while promoting premature cellular aging. Oxidative injury also disrupts the balance between proteases and antiproteases, leading to progressive alveolar destruction and emphysematous changes.

Pulmonary function tests provide objective measurements of respiratory mechanics and are indispensable for evaluating lung function in both healthy individuals and patients with respiratory disease. Spirometry remains the most commonly performed pulmonary function test because it is inexpensive, reproducible, non-invasive, and highly sensitive for detecting airflow limitation.

The principal spirometric parameters include Forced Vital Capacity (FVC), Forced Expiratory Volume in one second (FEV1), the FEV1/FVC ratio, Peak Expiratory Flow (PEF), Forced Expiratory Flow between 25% and 75% of vital capacity (FEF25–75%), and Maximum Voluntary Ventilation (MVV). These measurements provide valuable information regarding airway obstruction, restrictive lung disease, respiratory muscle performance, and overall ventilatory capacity.

Several epidemiological investigations have demonstrated that smokers experience accelerated decline in pulmonary function compared with non-smokers. Even young adults with relatively short smoking histories may demonstrate measurable reductions in expiratory airflow despite the absence of respiratory symptoms. The decline in lung function generally correlates with smoking duration, intensity, cumulative pack-years, and age.

Passive smoking also contributes significantly to respiratory dysfunction. Individuals exposed to environmental tobacco smoke exhibit increased airway inflammation, reduced pulmonary function, higher prevalence of chronic cough, and greater susceptibility to respiratory infections despite never actively smoking themselves.

Early identification of functional impairment is particularly important because smoking-related respiratory diseases often remain asymptomatic until substantial irreversible lung damage has occurred. Routine spirometric screening among smokers may therefore facilitate early diagnosis, encourage smoking cessation, and improve long-term respiratory outcomes.

Advances in computerized spirometry have enhanced the accuracy and reproducibility of pulmonary function testing. Modern equipment automatically compares measured values with age-, sex-, height-, and ethnicity-adjusted reference standards, allowing clinicians to identify subtle abnormalities that may otherwise remain undetected.

In addition to diagnosing chronic obstructive pulmonary disease (COPD), pulmonary function tests are valuable for monitoring asthma, occupational lung diseases, interstitial lung disorders, preoperative respiratory assessment, and evaluation of treatment response. They also play an important role in public health programs designed to identify high-risk individuals before irreversible pulmonary impairment develops.

The objective of this study is to compare pulmonary function test parameters between smokers and non-smokers, evaluate the physiological effects of cigarette smoking on respiratory performance, and assess the clinical value of spirometry in the early detection of smoking-related pulmonary dysfunction.

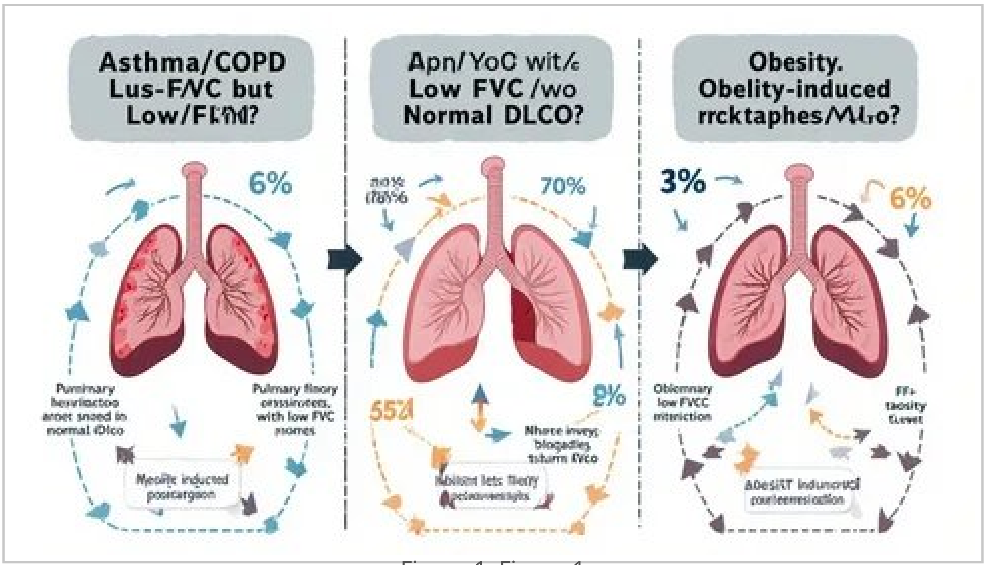

Figure 1. Figure 1

2. Materials and Methods

A prospective comparative cross-sectional study was conducted between January 2023 and June 2025 at the Department of Pulmonology and the Clinical Physiology Laboratory of a tertiary teaching hospital. The study aimed to compare pulmonary function test parameters between apparently healthy smokers and non-smokers and to determine the impact of cigarette smoking on respiratory performance.

A total of 240 adult participants were enrolled in the study. The study population consisted of 120 current smokers and 120 age- and sex-matched non-smokers who had never used tobacco products. Smokers were defined as individuals with a smoking history of at least one year and a cumulative exposure of five or more pack-years.

Participants between 20 and 60 years of age were eligible for inclusion. Individuals with previously diagnosed chronic obstructive pulmonary disease (COPD), bronchial asthma, pulmonary tuberculosis, interstitial lung disease, recent respiratory tract infection, thoracic surgery, severe cardiovascular disease, occupational exposure to respiratory toxins, or pregnancy were excluded.

A detailed questionnaire was completed for each participant, including demographic characteristics, smoking duration, number of cigarettes smoked per day, cumulative pack-years, occupational history, passive smoke exposure, physical activity, respiratory symptoms, and previous medical history.

Height, body weight, body mass index (BMI), blood pressure, respiratory rate, and oxygen saturation were measured before pulmonary function testing.

Spirometry was performed using a calibrated computerized spirometer according to the recommendations of the American Thoracic Society and the European Respiratory Society. Each participant performed at least three technically acceptable forced expiratory maneuvers, and the highest reproducible values were recorded.

The following pulmonary function parameters were evaluated:

- Forced Vital Capacity (FVC)
- Forced Expiratory Volume in one second (FEV_1)
- FEV_1/FVC ratio
- Peak Expiratory Flow (PEF)
- Forced Expiratory Flow at 25–75% of FVC (FEF_{25-75}%)
- Maximum Voluntary Ventilation (MVV)

Measured values were expressed as both absolute values and percentages of predicted normal values based on age, sex, height, and ethnicity.

Statistical analysis was performed using validated statistical software. Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. Student's t-test and Pearson correlation analysis were used to compare pulmonary function parameters between groups. A p-value < 0.05 was considered statistically significant.

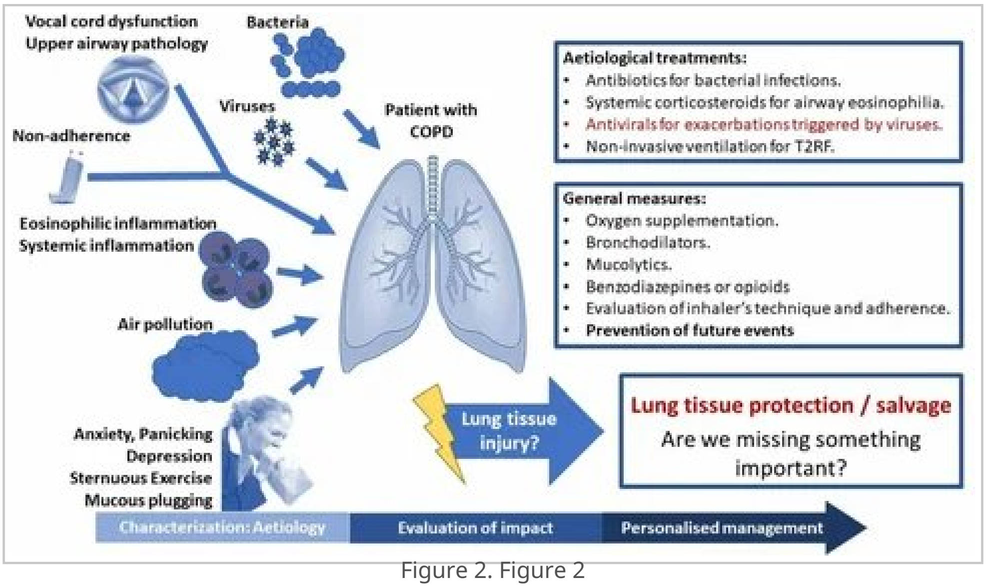

Figure 2. Figure 2

3. Results

Among the 240 participants, the mean age of smokers and non-smokers was comparable, with no statistically significant difference in body mass index or baseline demographic characteristics.
Current smokers demonstrated significantly lower pulmonary function compared with non-smokers. The mean FEV_1 was reduced in smokers, indicating early airflow limitation. Similarly, the FEV_1/FVC ratio showed a significant decline, suggesting obstructive changes within the airways.
Forced Vital Capacity was modestly reduced among smokers, although the reduction was less pronounced than that observed for FEV_1. This pattern was consistent with the early stages of obstructive airway disease rather than restrictive pulmonary impairment.
Peak Expiratory Flow and FEF_{25}–$_{75}$% were significantly lower in smokers, reflecting narrowing of both large and small airways. Decreased FEF_{25}–$_{75}$% was particularly evident in participants with longer smoking duration, indicating early involvement of peripheral airways before substantial clinical symptoms developed.
Maximum Voluntary Ventilation was also reduced among smokers, suggesting impaired ventilatory reserve and decreased respiratory muscle efficiency secondary to chronic airway inflammation.
A significant negative correlation was identified between cumulative smoking exposure (pack-years) and pulmonary function measurements. Participants with longer smoking histories demonstrated progressively lower FEV_1, FEV_1/FVC ratio, and expiratory flow rates.
Several smokers with normal chest radiographs and no respiratory complaints already demonstrated abnormal spirometric findings, emphasizing that functional impairment may precede clinically detectable pulmonary disease.

4. Discussion

The present study confirms that cigarette smoking has a substantial adverse effect on pulmonary function even in individuals without obvious respiratory symptoms. Smokers exhibited significantly reduced expiratory airflow, impaired ventilatory capacity, and evidence of early airway obstruction compared with healthy non-smokers.
The observed reduction in FEV_1 represents one of the earliest physiological manifestations of smoking-related lung injury. Chronic exposure to tobacco smoke induces persistent airway inflammation, mucus hypersecretion, epithelial damage, and gradual remodeling of bronchial walls. These pathological changes increase airway resistance and reduce expiratory airflow.
The decline in FEF_{25}–$_{75}$% observed among smokers suggests that small airway dysfunction develops before marked abnormalities appear in conventional spirometric measurements. Because peripheral airways contribute substantially to early chronic obstructive pulmonary disease, this parameter may serve as a sensitive marker of initial smoking-related lung damage.
Oxidative stress and chronic inflammation play central roles in the deterioration of pulmonary function. Reactive oxygen species generated by cigarette smoke damage alveolar epithelial cells,

impair surfactant function, activate inflammatory pathways, and accelerate destruction of elastic fibers. Progressive loss of elastic recoil contributes to airflow limitation and reduced expiratory performance.

The strong association between pack-years and declining pulmonary function indicates that cumulative tobacco exposure is directly related to the severity of respiratory impairment. This finding supports the importance of smoking cessation at the earliest possible stage before irreversible structural changes develop.

Routine spirometric evaluation of smokers provides an opportunity for early identification of respiratory dysfunction. Detecting subclinical airflow limitation may encourage smoking cessation, improve patient awareness, and permit timely intervention before the onset of chronic obstructive pulmonary disease or emphysema.

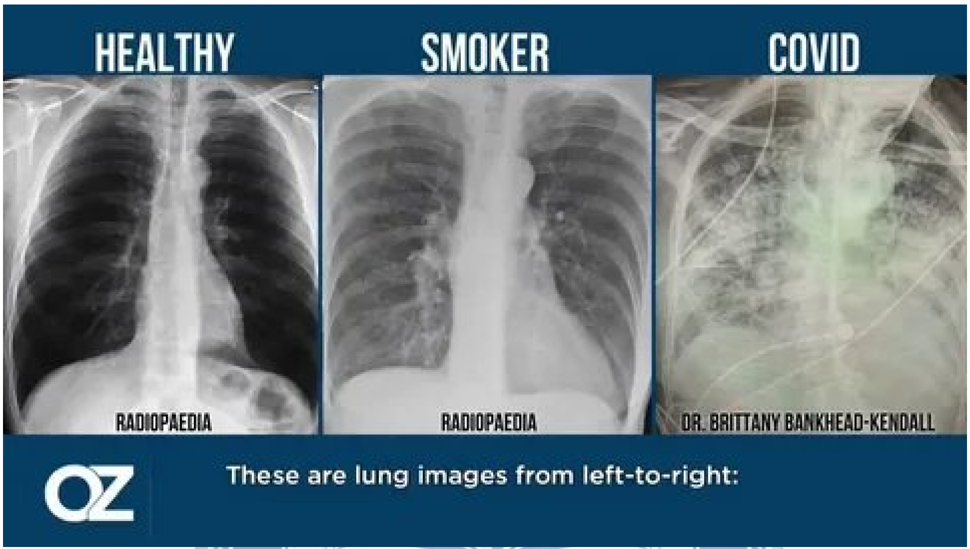

Figure 3. Figure 3

5. Conclusion

Pulmonary function tests provide an effective, safe, and non-invasive method for evaluating the impact of cigarette smoking on respiratory health.

Compared with non-smokers, smokers demonstrate significantly reduced FEV$_1$, FEV$_1$/FVC ratio, peak expiratory flow, and mid-expiratory flow rates, indicating early impairment of airway function even in the absence of clinical symptoms.

Routine spirometric screening among smokers can facilitate early diagnosis of smoking-related respiratory dysfunction, support smoking cessation programs, and reduce the long-term burden of chronic pulmonary disease. Integrating pulmonary function testing into preventive healthcare strategies may contribute substantially to improving respiratory outcomes and quality of life.

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