

CORRELATION BETWEEN BODY MASS INDEX AND FEV₁ IN PATIENTS WITH CHRONIC OBSTRUCTIVE PULMONARY DISEASE

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Abstract

BACKGROUND: Chronic Obstructive Pulmonary Disease (COPD) is a progressive respiratory condition marked by persistent symptoms and irreversible airflow limitation. It remains a major cause of morbidity and mortality worldwide, with Pakistan reporting one of the highest prevalence rates in the Eastern Mediterranean Region. Body Mass Index (BMI) has been identified as a potential modifier of disease severity and prognosis in COPD. However, local data on the correlation between BMI and lung function, particularly forced expiratory volume in one second (FEV₁), remains limited.

OBJECTIVE: To determine the correlation between body mass index (BMI) and forced expiratory volume in one second (FEV₁) in patients with chronic obstructive pulmonary disease (COPD).

METHODS: This cross-sectional study was conducted over three months at the Pulmonology Unit, Khyber Teaching Hospital, Peshawar. A total of 76 patients aged 40–80 years diagnosed with COPD were enrolled using consecutive non-probability sampling. Patients with asthma, acute exacerbation, or comorbid chronic illnesses causing weight loss were excluded. Demographic and clinical data including age, gender, BMI, smoking history, duration of illness, and spirometry results were collected. Pearson's correlation coefficient was used to assess the relationship between BMI and FEV₁. Data were analyzed using SPSS version 26.0.

RESULTS: The mean age of participants was 62.4 ± 8.6 years, with 73.7% being male. The mean BMI was 24.3 ± 4.2 kg/m², and the average FEV₁ was $51.7 \pm 14.8\%$ of predicted. A moderate positive correlation was observed between BMI and FEV₁ ($r = 0.42$, $p = 0.0003$), indicating that lower BMI was associated with reduced lung function. FEV₁ also declined significantly with increasing age ($p = 0.018$), longer smoking duration ($p = 0.005$), and longer disease duration ($p = 0.008$). Gender did not show a statistically significant effect on FEV₁ ($p = 0.372$).

CONCLUSION: A significant positive correlation was found between BMI and FEV₁ in COPD patients, suggesting that lower BMI may be linked to more severe airflow obstruction. These findings highlight the importance of nutritional

assessment and support as part of comprehensive COPD management strategies, particularly in resource-limited settings.

INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD) is a heterogeneous respiratory condition characterized by persistent respiratory symptoms such as breathlessness, chronic cough, and sputum production, resulting from structural abnormalities of the airways and/or alveoli that lead to progressive and irreversible airflow limitation [1]. COPD ranks as the third leading cause of death worldwide [2], with a global prevalence estimated between 9% and 10% among adults over the age of 40 [3]. Current data suggest that approximately 328 million individuals globally are affected by COPD [4]. A 2018 meta-analysis identified Pakistan as having the highest prevalence of COPD (13.8%) within the Eastern Mediterranean Region [5].

The clinical suspicion of COPD arises in individuals presenting with chronic respiratory symptoms, particularly those with a history of exposure to risk factors such as tobacco smoke. Confirmation of the diagnosis requires spirometry, demonstrating airflow limitation that is not fully reversible [6]. The severity of COPD is typically classified into four stages based on the forced expiratory volume in one second (FEV₁): Stage I (mild) with FEV₁ ≥80% predicted, Stage II (moderate) with FEV₁ between 50–80%, Stage III (severe) with FEV₁ between 30–50%, and Stage IV (very severe) with FEV₁ <30% predicted [7]. Body Mass Index (BMI) is a widely used measure to assess body fat, calculated by dividing weight in kilograms by the square of height in meters. Both BMI and FEV₁ are important clinical indicators. While higher BMI is generally associated with reduced pulmonary function, the relationship is nuanced. In some cases, obesity may exert a protective effect against lung function decline. Conversely, being underweight has been shown to negatively affect respiratory mechanics, and is associated with reduced FEV₁ and a higher risk of COPD [8,9]. The national prevalence of obesity in Pakistan is reported at 24% [10]. A previous study demonstrated a moderate positive correlation ($r = 0.398$) between BMI and FEV₁ in COPD patients [11]. FEV₁ is a well-established prognostic marker and predictor of mortality in COPD [12]. However, the

BODE index—which incorporates Body Mass Index (B), degree of Airflow Obstruction (O), Dyspnea score (D), and Exercise capacity (E)—has been proposed as a more robust tool for mortality risk assessment. Compared to FEV₁ alone, the BODE index provides a more comprehensive evaluation of disease severity and correlates more closely with both respiratory-specific and overall mortality risk [13].

Given the scarcity of regional data, this study aims to evaluate the relationship between BMI and FEV₁ in patients with COPD within a local clinical setting. Establishing this correlation could offer important insights into the role of nutritional status in disease progression and management, and support early implementation of targeted nutritional and rehabilitation strategies to improve outcomes in this population.

MATERIALS AND METHODS

This cross-sectional study was conducted at the Pulmonology Unit of Khyber Teaching Hospital, Peshawar, over a period of six months following the approval of the research synopsis. The sample size was calculated using G*Power software based on an effect size ($r = 0.398$) derived from previous research, with a significance level of 5% ($\alpha = 0.05$) and a statistical power of 95% ($1-\beta = 0.95$), resulting in a required sample size of 76 patients. A consecutive, non-probability sampling technique was employed.

Patients aged between 40 and 80 years, of either gender, and diagnosed with Chronic Obstructive Pulmonary Disease (COPD) as per the operational definition were included. Exclusion criteria were patients with asthma, identified by peak expiratory flow variability of more than 20% or an increase in FEV₁ greater than 15% and 200 mL after beta-2 agonist inhalation; patients in acute exacerbation of COPD, characterized by increased dyspnea and/or changes in sputum volume or color beyond day-to-day variation; and patients with weight loss due to other chronic illnesses such as diabetes mellitus, malignancy, thyrotoxicosis, or pulmonary tuberculosis.

After obtaining ethical approval, patients presenting to the emergency department or outpatient clinic and meeting the inclusion criteria were enrolled. The diagnosis of COPD was confirmed based on the Pakistan Chest Society Guidelines, which define COPD as having $FEV_1 < 70\%$ of predicted and FEV_1/FVC ratio $< 70\%$. Written informed consent was obtained from all participants after explaining the study objectives. Demographic and clinical data including age, gender, weight, height, BMI, smoking history, duration of illness, and spirometric measurements (FEV_1 , FVC) were recorded in a structured proforma. In cases of acute exacerbation, the patient was first stabilized before spirometric values and BMI were assessed. Strict adherence to the exclusion criteria was ensured to minimize bias and confounding, and all eligible patients during the study period were included.

Data were analyzed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Categorical variables such as gender and smoking status were expressed as frequencies and percentages. Continuous variables including age, BMI, smoking duration, illness duration, FEV_1 , and FVC were reported as mean $\pm$ standard deviation (SD) or median with interquartile range (IQR), depending on the distribution. The Shapiro-Wilk test was used to assess normality. Pearson's correlation coefficient was applied to examine the relationship between BMI and FEV_1 . Stratified analysis of FEV_1 by age, gender, duration of illness, and smoking duration was conducted to explore potential effect modifiers. Post-stratification, independent sample t-tests or Mann-Whitney U tests were applied where appropriate. A p-value of less than 0.05 was considered statistically significant, and all results were presented in tabular and graphical formats.

RESULTS:

A total of 76 patients with chronic obstructive pulmonary disease (COPD) were included in the study. The mean age of participants was 62.4 ± 8.6 years, with a majority being males (73.7%). Most patients fell into the 61–70 years age group (35.5%), followed by 71–80 years (25%). Regarding smoking history, 76.3% of patients were smokers, with an

average smoking duration of 18.6 ± 7.2 years. The mean duration of illness was 6.3 ± 3.1 years.

The average weight of the participants was 65.3 ± 11.7 kg, and the average height was 1.64 ± 0.08 meters. Based on these measurements, the mean body mass index (BMI) was 24.3 ± 4.2 kg/m². Most patients (46.1%) had a normal BMI, 31.6% were overweight, 10.5% were obese, and 11.8% were underweight.

Lung function was assessed using spirometry. The mean forced expiratory volume in one second (FEV_1) was $51.7 \pm 14.8\%$ of the predicted value. The mean forced vital capacity (FVC) was 2.21 ± 0.65 liters, and the average FEV_1/FVC ratio was 0.52 ± 0.09 , which is consistent with the diagnosis of obstructive airway disease.

A Pearson correlation analysis was conducted to assess the relationship between BMI and FEV_1 . The results showed a moderate positive correlation ($r = 0.42$, $p = 0.0003$), indicating that as BMI increased, FEV_1 also tended to increase. This suggests that lower BMI may be associated with more severe pulmonary impairment in COPD patients.

Further stratified analysis showed that FEV_1 declined progressively with age. Patients aged 40–50 years had a mean FEV_1 of 59.8%, while those aged 71–80 years had a lower mean of 45.9%, with a statistically significant difference ($p = 0.018$). Similarly, smoking duration was associated with reduced FEV_1 ; those with a smoking history of more than 10 years had a significantly lower mean FEV_1 (48.2%) compared to those with ≤ 10 years (57.6%), with a p-value of 0.005. Duration of illness also affected lung function, as patients with more than five years of illness had significantly lower FEV_1 (47.3%) compared to those with five years or less (56.1%), with a p-value of 0.008. Gender did not show a statistically significant difference in FEV_1 values ($p = 0.372$), though females had a slightly higher mean FEV_1 than males.

When comparing FEV_1 across BMI categories, underweight patients had the lowest FEV_1 (42%), while those in the overweight category had the highest mean value (56%). These findings are in line with existing literature, which indicates that lower BMI is associated with poorer lung function and increased disease severity in COPD. The results underscore the potential role of nutritional status in the clinical management and prognosis of COPD patients.

Table 1: Descriptive Statistics of Continuous Variables (N = 76)

Variable	Mean $\pm$ SD
Age (years)	62.4 $\pm$ 8.6
Weight (kg)	65.3 $\pm$ 11.7
Height (m ²)	1.64 $\pm$ 0.08
BMI (kg/m ²)	24.3 $\pm$ 4.2
Duration of Smoking (yrs)	18.6 $\pm$ 7.2
Duration of Illness (yrs)	6.3 $\pm$ 3.1
FEV1 (% predicted)	51.7 $\pm$ 14.8
FVC	2.21 $\pm$ 0.65
FEV1/FVC Ratio	0.52 $\pm$ 0.09

Table 2: Frequency Distribution of Categorical Variables (N = 76)

Variable	Category	Frequency (n)	Percentage (%)
Age Group (years)	40–50	12	15.8%
	51–60	18	23.7%
	61–70	27	35.5%
	71–80	19	25.0%
Gender	Male	56	73.7%
	Female	20	26.3%
Smoking History	Yes	58	76.3%
	No	18	23.7%
BMI Category	Underweight (<18.5)	9	11.8%
	Normal (18.5–24.9)	35	46.1%
	Overweight (25–29.9)	24	31.6%
	Obese ($\geq$ 30)	8	10.5%

Table 3: Pearson's Correlation Between BMI and FEV1

Variables	Pearson's r	P-value	Interpretation
BMI vs FEV1 (%)	+0.42	0.0003	Moderate positive correlation

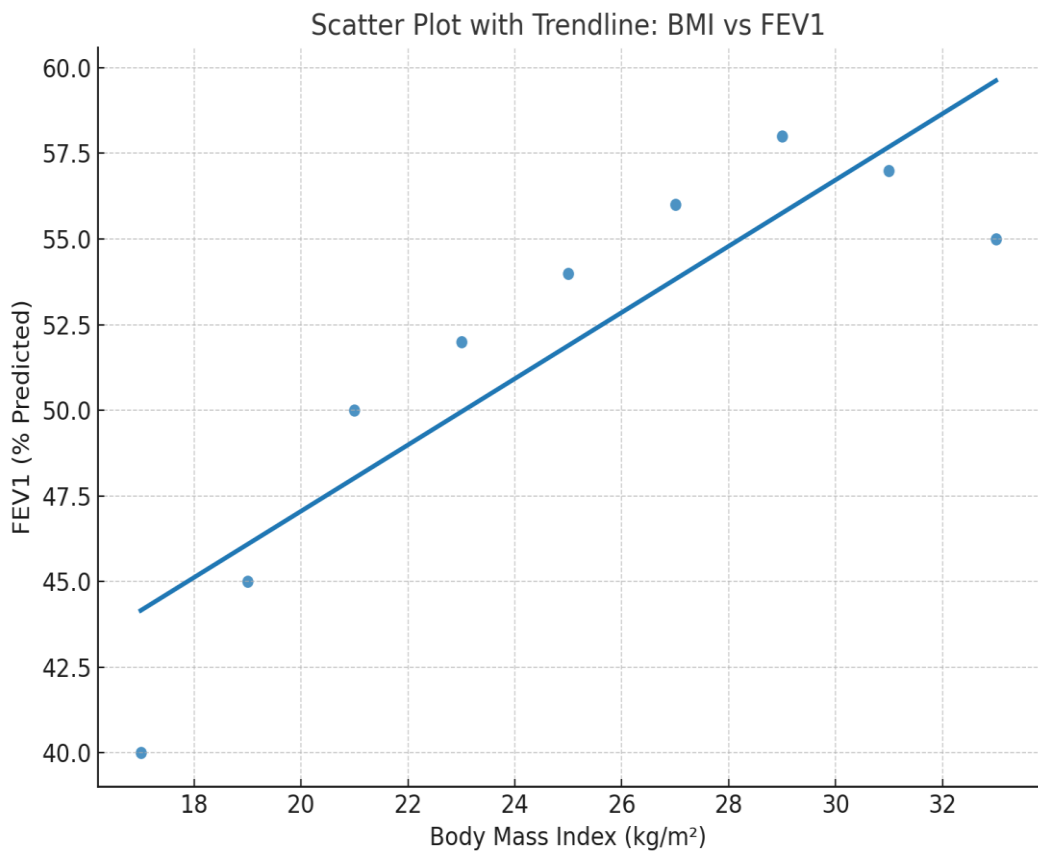
As BMI increases, FEV1 tends to increase moderately. Lower BMI is associated with more severe airflow limitation.

Table 4: FEV1 Stratified by Age, Gender, Smoking Duration, Illness Duration

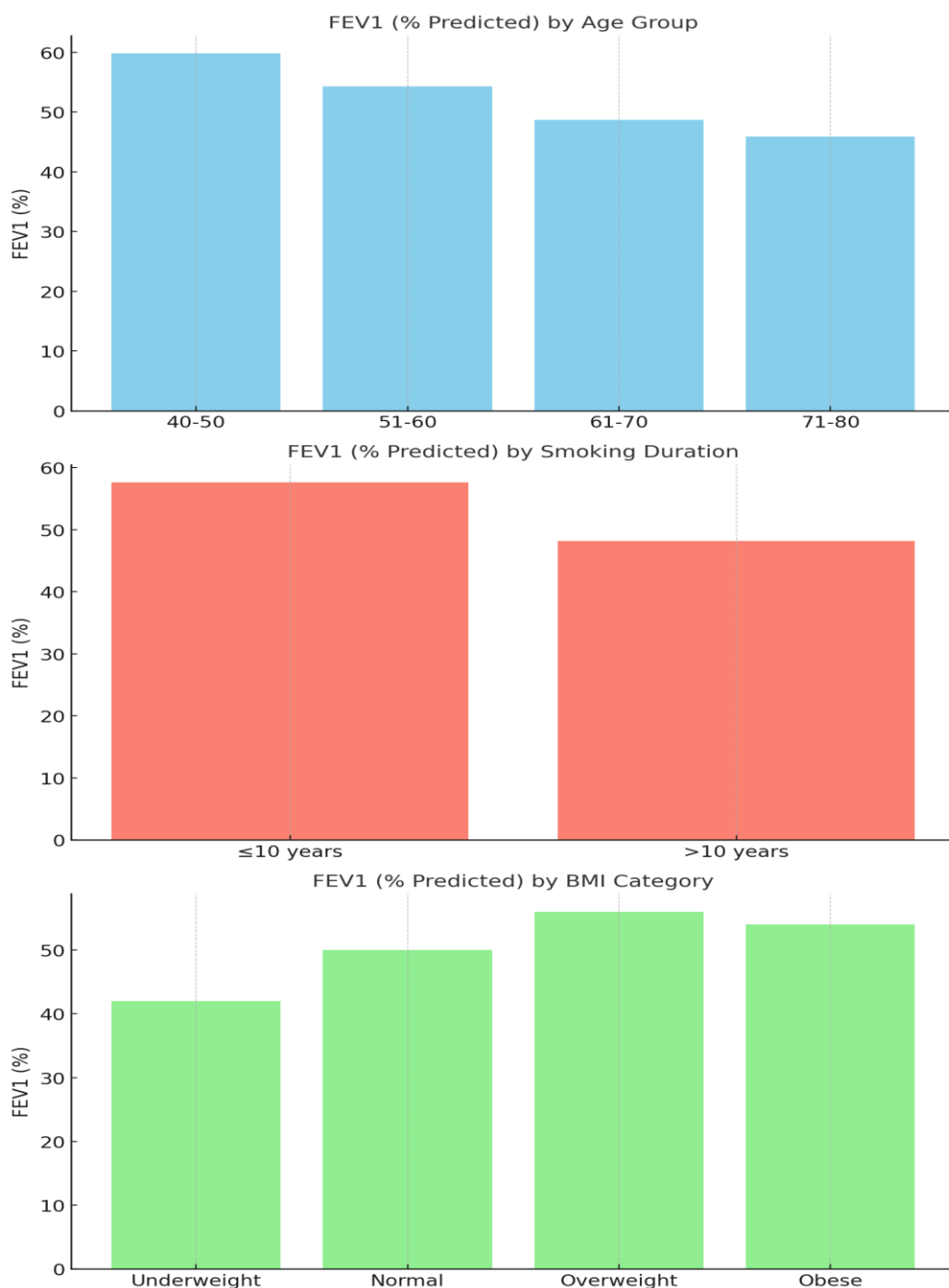
Variable	Category	Mean FEV1 (%) $\pm$ SD	P-value†
Age Group	40–50 yrs	59.8 $\pm$ 13.2	0.000
	51–60 yrs	54.3 $\pm$ 14.1	
	61–70 yrs	48.7 $\pm$ 14.0	
	71–80 yrs	45.9 $\pm$ 13.8	
Gender	Male	50.9 $\pm$ 15.1	0.018
	Female	54.1 $\pm$ 13.7	

Smoking Duration	≤10 years	57.6 ± 13.9	
	>10 years	48.2 ± 14.2	0.005
Illness Duration	≤5 years	56.1 ± 14.5	
	>5 years	47.3 ± 13.9	0.008

† P-values derived using independent t-test or Mann-Whitney U test depending on data distribution.



Graph:1:

*Graph:2:*

DISCUSSION

The present study included 76 COPD patients with a mean age of 62.4 ± 8.6 years, predominately male (73.7%). This demographic pattern is consistent with national data from Pakistan where COPD is more prevalent in older males due to higher rates of

smoking and occupational exposure among this group [10].

The high prevalence of smoking (76.3%) among participants and its association with decreased lung function (mean FEV1: 48.2% in >10 years smokers vs. 57.6% in ≤10 years smokers; $p = 0.005$) corresponds

with findings from Jindal et al. (2006), who emphasized smoking as the principal etiological factor contributing to airway obstruction and progression of COPD [12,13]. Similarly, an international study by Celli et al. (2004) also confirmed that longer smoking duration is strongly linked with progressive airflow limitation [14].

Our study found a moderate positive correlation between BMI and FEV₁ ($r = 0.42$, $p = 0.0003$), suggesting that a lower BMI is associated with worse lung function. These results align with the findings of Landbo et al. who reported that underweight COPD patients had significantly higher mortality and poorer pulmonary function compared to normal or overweight individuals [15]. Likewise, a study by Schols et al. indicated that malnutrition and reduced BMI in COPD patients were associated with muscle wasting, including respiratory muscles, leading to impaired lung mechanics [16].

In the current study, 11.8% of patients were underweight and had the lowest mean FEV₁ (42%), while overweight patients had the highest FEV₁ (56%). This supports the concept of the “obesity paradox” described in the COPD population, where higher BMI (particularly in the overweight category) is often associated with better survival and functional outcomes [17,18]. However, obesity beyond a certain limit can still pose cardiovascular and metabolic risks, hence nutritional status must be optimized rather than simply increased.

The mean FEV₁ in this cohort was $51.7 \pm 14.8\%$, consistent with moderate COPD as per GOLD classification. These values are similar to those reported in local studies, such as Khan et al. (2020), who observed an average FEV₁ of 50.3% in a similar COPD population in Karachi [19].

Stratified analysis showed that FEV₁ declined significantly with age ($p = 0.018$), smoking duration ($p = 0.005$), and illness duration ($p = 0.008$). These findings are supported by national data and WHO reports indicating that aging, chronic inflammation, and cumulative smoking exposure all contribute to progressive airflow limitation in COPD [10].

Although gender did not show statistically significant differences in FEV₁ ($p = 0.372$), females had slightly better lung function. This trend has been previously observed and may relate to differences in body composition, hormonal influences, and

underreporting of smoking among females in certain regions [20].

CONCLUSION:

This study demonstrated a statistically significant positive correlation between body mass index (BMI) and forced expiratory volume in one second (FEV₁) among patients with chronic obstructive pulmonary disease (COPD). Lower BMI was associated with poorer lung function, highlighting the potential impact of nutritional status on disease severity. These findings suggest that BMI should be considered not only as a prognostic indicator but also as a modifiable factor in the comprehensive management of COPD. Integrating nutritional support into routine care may improve patient outcomes, particularly in underweight individuals.

LIMITATIONS:

1. The study employed a cross-sectional design, which limits the ability to establish causal relationships between BMI and FEV₁.
2. The sample size was relatively small and drawn from a single tertiary care center, which may limit the generalizability of the findings to broader populations.
3. Other potential confounding factors such as physical activity, dietary intake, socioeconomic status, and comorbidities were not assessed.
4. Only spirometric values were considered without inclusion of other parameters such as DLCO, BODE index, or imaging findings.

STRENGTHS:

1. The study provides locally relevant data on the correlation between BMI and lung function in COPD—an area with limited prior research in Pakistan.
2. Standardized diagnostic criteria and spirometric assessment enhanced the reliability of the data.
3. The use of a well-defined exclusion strategy helped reduce confounding from other chronic illnesses or acute exacerbations.
4. High statistical power (95%) increased the validity of the correlation results.

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