Available online at Journal Website
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Main Subject [Respiratory Medicine]

## Original Article

# Prevalence and Severity of Metabolic Syndrome in COPD Patients - A Cross Sectional Observational Study

**K. Pukazhenthi [1], Kondrakunta Bhagya Sree Divya [2], Appandraj Srivijayan [2], Jercy Grace [*3]**

[1] Department of Respiratory Medicine, Melmaruvathur Adhiparasakthi Institute of Medical Sciences and Research, Melmaruvathur, Tamil Nadu, India.
[2] Department of General Medicine, Melmaruvathur Adhiparasakthi Institute of Medical Sciences and Research, Melmaruvathur, Tamil Nadu, India.
[3] Department of General Medicine, Panimalar Medical College Hospital and Research Institute, Chennai, India.

**Article information**

**Received:** 13-01-2024

**Accepted:** 07-04-2024

DOI: 10.21608/IJMA.2024.262520.1909.

*Corresponding author
**Email:** drjercygrace@gmail.com

**Citation:** Pukazhenthi K, Divya KBS, Srivijayan A, Grace J. Prevalence and Severity of Metabolic Syndrome in COPD Patients - A Cross Sectional Observational Study. IJMA 2024 April; 6 [4]: 4338-4346. doi: 10.21608/IJMA. 2024.262520.1909.

## ABSTRACT

**Background:** An adequate amount of environmental stimulation is the factor that causes COPD in a sensitive lung. In low- and middle-income nations, COPD is a silent killer. Metabolic syndrome is generally a cluster of five components: a high triglyceride level, high blood pressure, abdominal obesity, high glucose level, and low high-density lipoprotein cholesterol. A notable correlation has been documented between the two conditions, and a substantial linkage between diminished lung function and metabolic syndrome is supported by both clinical and epidemiological evidence.

**The aim of the work:** The purpose of this study was to determine the prevalence and severity of metabolic syndrome in individuals with COPD.

**Patients and Methods:** In the Department of Respiratory Medicine, this prospective observational study was carried out. All the patients Diagnosed COPD as per GOLD Guidelines 2015 in Respiratory Medicine department at Chettinad Hospital and Research Institute from October 2016 to October 2017 were incorporated into the study. Prior to the study's sample size being met, all eligible participants were progressively selected by convenient sampling.

**Results:** A total of 66 participants were included in the study. The mean age was 54.45 ± 9.32 in the study population. 51 [77.30%] participants were male and 15 [22.70%] were females. The mean FEV1 was 1.82 ± 0.7 in the study population. The mean FVC was 2.85 ± 0.94 and the mean FEV1/FVC was 0.62 ± 0.08 in the study population. Among the study population, 4 [6.06%] participants had metabolic syndrome. A marginally negative association was found between FEV1/FVC and waist circumference and was statistically significant [r value: -0.272, P value: 0.027].

**Conclusion:** There was a 6% metabolic syndrome prevalence in COPD patients. Abdominal obesity showed statistically significant association with lower lung functions. In terms of pulmonary function metrics, there were no discernible differences between COPD patients with metabolic syndrome.

**Keywords:** COPD; Metabolic syndrome; Respiratory medicine; Lung disease.

## INTRODUCTION

Chronic obstructive pulmonary disease [COPD] is defined by the Global Initiative for Chronic Obstructive Lung Disease [GOLD] as a widespread illness that is curable, preventive, and characterized by a continuous obstruction of airflow that is generally progressive and linked to an elevated long-term inflammation brought caused by hazardous particles or gases in the lungs and airways [1].

Chronic Obstructive Pulmonary Disease [COPD] is a primary concern for public health [2]. It is characterized by bronchitis linked to pulmonary hypertension, small airways disease and emphysema. There is ample evidence that COPD is a chronic condition; it is marked by a persistent reduction in lung function associated with narrowing of the airways brought on by fibrosis and inflammation and mucus plugging, and parenchymal degeneration accompanied by an elasticity decrease, gas exchange surface area, and airway assistance followed by an early airway closure [3].

A sensitive lung that has been exposed to enough environmental stimuli will eventually develop COPD. Primarily brought on by household air pollution and smoking cigarettes, in nations with modest to moderate incomes, COPD is a silent killer [2]. Globally, there were 251 million COPD cases in 2016 and 3.15 million fatalities are estimated to be caused by COPD annually [4]. In 2012, a systematic review found that in India, the prevalence of COPD ranges from 6.5% to 7.68% and by 2030, it might rank as the second the primary cause of death [5].

The phrase "metabolic syndrome" describes an ensemble of interrelated cardiovascular risk variables that are prevalent metabolic disorders [6]. It is commonly described as an assemblage of five components: a high glucose level, abdominal obesity, high blood pressure, low high-density lipoprotein cholesterol and high triglyceride level [7]. Metabolic Syndrome in COPD patients has been linked to a number of risk factors: smoking habit, obesity, systemic inflammation, sedentary lifestyle, obstruction and airway inflammation and physical inactivity [8]. Minimal information exists regarding the likelihood that COPD patients have the metabolic syndrome. **Marquis *et al.*** [9] outlined an elevated occurrence in 47% of patients with COPD. In 57% of cases, metabolic syndrome was reported with COPD in research done by **Breyer *et al.*** [10].

COPD significantly affects the quality of life for those who are impacted by the condition, as well as on the local economies of those affected, those who offer medical assistance and care to individuals who are impacted [2].

Currently, two common clinical illnesses are Metabolic Syndrome and Chronic Obstructive Pulmonary Disease that have a major effect on public health, it is anticipated that these diseases would become more common in the coming years, placing an increasing burden on the world economy. There is a documented substantial correlation between the two disorders and data from both clinical and epidemiological studies indicate a substantial relationship between lung function deterioration and metabolic syndrome. But it's still unclear exactly what this partnership entails [11]. Consequently, the objective of the study was to ascertain the incidence and severity of metabolic syndrome in individuals with COPD.

## PATIENTS AND METHODS

**Study site:** The study was carried out in the Respiratory Medicine Department.

**Study population:** All the patients Diagnosed COPD as per GOLD Guidelines 2015 were regarded as the subjects of the study.

**Study design:** Prospective Observational study was carried out.

**Sample size:** As per study by **Koul** [13] the expected proportion of metabolic syndrome was considered as 34%. To be able to detect this proportion with 12% absolute precision and 95% confidence level, the formula below was used to determine the sample size.

$$n = \frac{Z^2 P(1-P)}{d^2}$$

Where n = Sample size, Z = Z statistic for a level of confidence = 1.96, P = Expected prevalence of proportion [If the expected prevalence is 34%, then P = 0.34], and d = Precision [If the precision is 5%, then d = 0.12].

Considering the formula described above, a sample size of 60 participants was needed. To account for a non-participation rate of 10%, the sample size was increased by six more subjects. The final analysis had included 66 subjects.

**Sampling method:** All qualified subject was enlisted in the study gradually through practical sampling until the required sample size is attained.

**Study duration:** Study data were gathered from October 2016 to October 2017.

**Inclusion Criteria:** [1] Patients of COPD diagnosed as per GOLD guidelines 2015, and [2] Age - 40-80 years.

**Exclusion criteria:** [1] OAD other than COPD, [2] Uncooperative patient, and [3] Active PT, haemoptysis, pneumonia.

**Ethical considerations:** The institutional human ethics committee approved the study. Written informed consent was given by each study participant, and participation in the research was restricted to those who were willing to sign it. Before giving their agreement, the participants were made aware of the advantages and drawbacks of the study, as well as the fact that participation was entirely voluntary. The research participants' confidentiality was protected.

**Data collection tools:** A standardized study proforma was used to record all the pertinent parameters.

**Methodology**

**MODIFIED NCEP ATP III:** [1] Triglycerides: > 150 mg/dl or medical treatment, [2] HDL cholesterol: < 40 mg/dl for men and < 50 mg/dl for women, [3] Systolic blood pressure ≥ 130 mmHg and/or diastolic blood pressure ≥ 85 mmHg or current use of antihypertensive drugs, [4] Impaired Fasting glucose [fasting plasma glucose] ≥ 100 mg/dl or glucose lowering medications, and [5] Increased waist circumference: ≥ 40 inch in male and ≥ 35 inch in female.

**Table [1]:** Gold staging

| Gold stage | COPD severity | $FEV_1/FVC$ ratio | FEV Range[a] |
|---|---|---|---|
| **I** | Mild | < 0.70 | ≥ 80% of normal |
| **II** | Moderate | < 0.70 | 50% - 79% of normal |
| **III** | Severe | < 0.70 | 30% - 49% of normal |
| **IV** | Very severe | < 0.70 | < 30% of normal or <50% of normal with chronic respiratory failure present |

[a] As recorded in electronic health records, which did not specify pre or post bronchodilator

## RESULTS

This analysis included 66 participants in total. The lowest age in the study population was 40 years old, and the maximum age was 78 years old, and the mean age was 54.45 ± 9.32. [95% CI 52.16 to 56.75]. Among the people under study, 51 [77.3%] participants were male and remaining 15 [22.70%] participants were female [Figure 1].

The mean weight was 65.97 ± 11.36 in the study population. Range was between 46 Kg to 92 Kg [95% CI 63.18 to 68.76]. The mean height was 1.63 ± 0.08 m in the study population. Range was between 1.41 m to 1.79 m [95% CI 1.61 to 1.65]. The mean BMI was 24.96 ± 5.13 in the study population. Range was between 15.75 to 42.80 [95% CI 23.70 to 26.22]. The mean waist circumference was 81.03 ± 8.85 in the study population. Range was between 62 to 104 [95% CI 78.85 to 83.21] [Table 2].

The mean FEV1 was 1.82 ± 0.7 in the study population. Range was between 0.71 to 3.31 [95% CI 1.65 to 1.99]. The mean FVC was 2.85 ± 0.94 in the study population. Range was between 1.12 to 4.91 [95% CI 2.62 to 3.09]. The mean FEV1/FVC was 0.62 ± 0.08 in the study population. Range was between 0.36 to 0.70 [95% CI 0.61 to 0.64] [Table 3].

The incidence of different components of the metabolic syndrome and the descriptive analysis of clinical symptoms in the study population were reported in [Table 4 and 5].

Among the subjects who had metabolic syndrome, the median Forced expiratory volume in 1 sec was 1.455 [IQR [inter quarantine ranging] 1.08 to 1.65] and it was 1.6 [IQR 1.42 to 2.35] in subjects who never experienced metabolic syndrome. The difference in the FEV1/FVC between metabolic syndrome groups was not statistically significant [P Value 0.240] [Table 6].

A marginally negative association was observed between FEV1/FVC and age [r value: -0.142, P value: 0.256]. A marginally negative association was observed between FEV1/FVC and weight [in kg] [r value: -0.209, P value: 0.092]. There was just a marginally positive association between COPD and height [in m] [r value: 0.148, P value: 0.236]. A marginally negative association was found between FEV1/FVC and BMI [r value: -0.240, P value: 0.052]. A marginally negative association

was observed between FEV1/FVC and abdominal obesity [r value: -0.272, P value: 0.027] [Table 7].

There was a weak positive correlation between FEV1/FVC and systolic blood pressure [r value: 0.129, P value: 0.302]. There was a weak positive correlation between FEV1/FVC and diastolic blood pressure [r value: 0.162, P value: 0.192]. There was a weak negative correlation between FEV1/FVC and fasting blood sugar [mg/dl] [r value: -0.060, P value: 0.630]. There was a weak negative correlation between FEV1/FVC and triglycerides [mg/dl] [r value: -0.109, P value: 0.383]. There was a weak negative correlation between FEV1/FVC and HDL [mg/dl] [r value: -0.149, P value: 0.232]. There was a weak negative correlation between FEV1/FVC and abdominal obesity [r value: -0.272, P value: 0.027] [Table 8].

Among the study population, 16 [24.24%] patients had mild FEV1, 28 [42.42%] participants had moderate FEV1 and 22 [33.33%] participants had severe FEV1. [Table 9].

Out of the 4 participants who had metabolic syndrome, two [50%] participants had moderate COPD and two [50%] participants had severe COPD. Also, out of the 62 participants who did not have metabolic syndrome, 16 [25.80%] had mild COPD, 26[41.93%] had moderate COPD and 20 [32.25%] had severe COPD [Table 10].

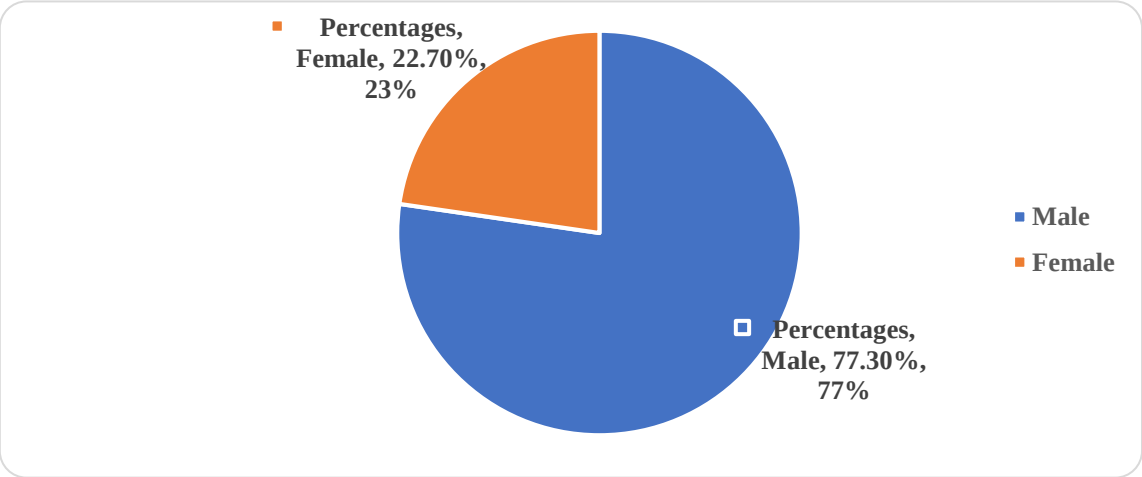


**Figure [1]:** Descriptive analysis of gender in the study population [n=66]

**Table [2]:** Descriptive analysis of anthropometric parameter in study population [n=66]

| Parameter | Mean ± SD | Median | Min | Max | 95% C.I | |
|---|---|---|---|---|---|---|
| | | | | | Lower | Upper |
| **Weight [kg]** | 65.97 ± 11.36 | 66.00 | 46.00 | 92.00 | 63.18 | 68.76 |
| **Height [m]** | 1.63 ± 0.08 | 1.64 | 1.41 | 1.79 | 1.61 | 1.65 |
| **Body mass index** | 24.96 ± 5.13 | 23.42 | 15.75 | 42.80 | 23.70 | 26.22 |
| **Waist circumference [cm]** | 81.03 ± 8.85 | 80.00 | 62.00 | 104.00 | 78.85 | 83.21 |

**Table [3]:** Descriptive analysis of FEV1, FVC and FEV1/FVC in study population [n=66]

| Parameter | Mean ± SD | Median | Min | Max | 95% C.I | |
|---|---|---|---|---|---|---|
| | | | | | Lower | Upper |
| **FEV1 [L]** | 1.82 ± 0.7 | 1.60 | 0.71 | 3.31 | 1.65 | 1.99 |
| **FVC [L]** | 2.85 ± 0.94 | 2.48 | 1.12 | 4.91 | 2.62 | 3.09 |
| **FEV1/FVC** | 0.62 ± 0.08 | 0.65 | 0.36 | 0.70 | 0.61 | 0.64 |

**Table [4]:** Descriptive analysis of clinical signs in study population [n=66]

| Parameter | Mean ± SD | Median | Min | Max | 95% C.I | |
|---|---|---|---|---|---|---|
| | | | | | Lower | Upper |
| **Systolic blood pressure** | 126.73 ± 14.25 | 130.00 | 110.00 | 150.00 | 123.22 | 130.23 |
| **Diastolic blood pressure** | 82.3 ± 8.01 | 80.00 | 70.00 | 92.00 | 80.33 | 84.27 |
| **Fasting blood sugar [mg/dl]** | 110.44 ± 14.45 | 112.00 | 84.00 | 134.00 | 106.89 | 113.99 |
| **Triglycerides [mg/dl]** | 107.3 ± 11.85 | 106.00 | 86.00 | 132.00 | 104.39 | 110.22 |
| **HDL [mg/dl]** | 47.59 ± 6.53 | 48.00 | 32.00 | 62.00 | 45.98 | 49.20 |
| **Waist circumference [cm]** | 81.03 ± 8.85 | 80.00 | 62.00 | 104.00 | 78.85 | 83.21 |

**Table [5]:** Descriptive analysis of prevalence of various metabolic syndrome components

| Parameter | | Frequency | Percent |
|---|---|---|---|
| **Abdominal obesity** | Yes | 3 | 4.50% |
| | No | 63 | 95.50% |
| **Triglycerides** | High | 0 | 0.0% |
| | Normal | 66 | 100% |
| **HDL-Cholesterol** | High | 3 | 4.50% |
| | Normal | 63 | 95.50% |
| **Hypertension** | Yes | 43 | 65.20% |
| | No | 23 | 34.80% |
| **Fasting blood sugar** | High [>=100] | 48 | 72.70% |
| | Normal [<100] | 18 | 27.30% |

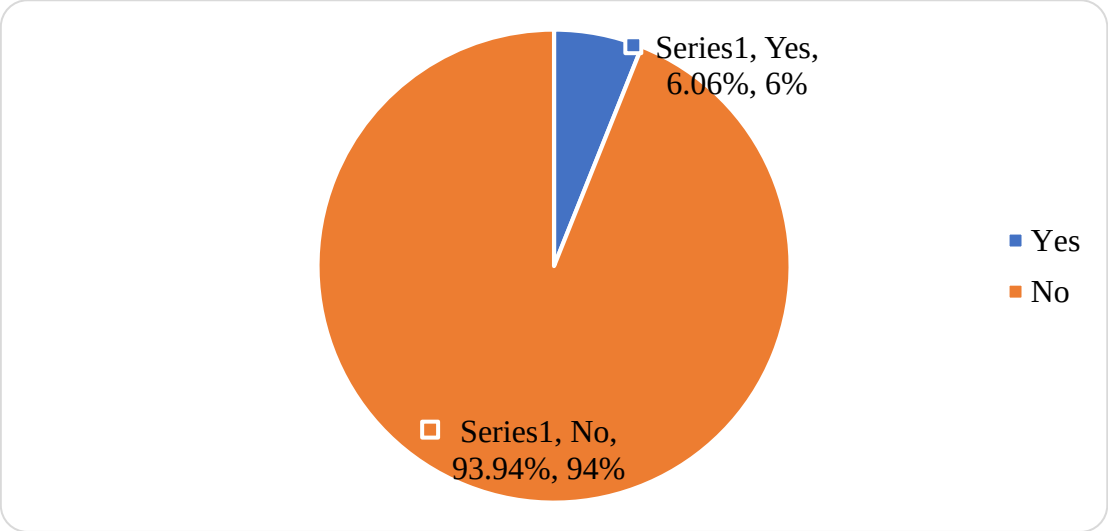


**Figure [2]:** Pie chart of metabolic syndrome in the study population [n=66]

**Table [6]:** Comparison of FEV1, FVC and FEV1/FVC median Metabolic Syndrome population

| PFT parameters | Metabolic syndrome group | | P value [Mann Whitney U test] |
|---|---|---|---|
| | Metabolic syndrome [n=4] | No Metabolic syndrome [n=62] | |
| **Forced expiratory volume in 1 Median [IQR]** | 1.455 [1.08, 1.65] | 1.6 [1.42, 2.35] | 0.320 |
| **Forced vital capacity Median [IQR]** | 2.44 [1.85, 2.63] | 2.495 [2.23, 3.42] | 0.468 |
| **FEV1/FVC, Median [IQR]** | 0.61 [0.53, 0.655] | 0.65 [0.59, 0.69] | 0.240 |

**Table [7]:** Correlation between FEV1/FVC with various anthropometric parameters in the study population [n= 66]

| Parameter | Pearson Correlation | P value |
|---|---|---|
| **Age** | -0.142 | 0.256 |
| **Weight [in kg]** | -0.209 | 0.092 |
| **Height [in m]** | 0.148 | 0.236 |
| **Body mass index** | -0.240 | 0.052 |
| **Abdominal Obesity** | -0.272 | 0.027 |

**Table [8]:** Correlation between FEV1/FVC with Metabolic Syndrome parameters in the study population [n= 66]

| Parameter | Pearson Correlation | P value |
|---|---|---|
| **Systolic blood pressure** | 0.129 | 0.302 |
| **Diastolic blood pressure** | 0.162 | 0.192 |
| **Fasting blood sugar [mg/dl]** | -0.060 | 0.630 |
| **Triglycerides [mg/dl]** | -0.109 | 0.383 |
| **HDL [mg/dl]** | -0.149 | 0.232 |
| **Abdominal Obesity** | -0.272 | 0.027 |

**Table [9]:** Descriptive analysis of COPD severity [Based FEV1 level] in study population [n=66]

| COPD severity [Based FEV1 level] | Frequency | Percentages |
|---|---|---|
| **Mild [≥80%]** | 16 | 24.24% |
| **Moderate [50% -79%]** | 28 | 42.42% |
| **Severe [30% - 49%]** | 22 | 33.33% |

**Table [10]:** Comparison of COPD severity with Metabolic Syndrome [n=66]

| Metabolic Syndrome | COPD severity | | |
|---|---|---|---|
| | **Mild** | **Moderate** | **Severe** |
| **Yes [n=4]** | 0 [0%] | 2 [50%] | 2 [50%] |
| **No [n=62]** | 16 [25.80%] | 26 [41.93%] | 20 [32.25%] |

*No statistical test was applied- due to 0 subjects in the cells

## DISCUSSION

The global burden of COPD is expected to rise over the coming years due to the aging population and continued exposure to risk factors of COPD. Over the past ten years, the definition of COPD has changed from a simple perspective of the disease that is centered on airflow limitation to one that characterizes COPD as a complex and diverse syndrome with notable extra-pulmonary manifestations, including skeletal muscle dysfunction, diabetes, and cardiovascular disease [12, 13]. A common metabolic illness known as the metabolic syndrome is defined by a collection of interrelated cardiovascular risk factors [6]. Several longitudinal and cross-sectional investigations have found a connection between COPD and metabolic syndrome [MetS]. Moreover, it has been discovered that the syndrome is a separate risk factor for asthma, pulmonary hypertension, progressive deterioration of lung function, and exacerbation of respiratory symptoms [12, 13]. Given that the prevalence of MetS in the general population is very high, it's important to have a deeper comprehension of the mutual influence of the two in order to develop suitable management plans [13]. Therefore, the aim of the study was to ascertain how the metabolic syndrome and COPD are related. The analysis included a total of 66 participants.

COPD has been associated with a higher incidence of metabolic syndrome, according to several studies. In the current study, 4 participants [6.06%] had metabolic syndrome. In a study conducted by **Koul** [13], 34% of COPD patients had metabolic syndrome. The prevalence was even higher in the study by **Verma *et al.*** [14], where metabolic syndrome was found in 11 subjects [15.7%] out of 70. Additionally, in the study by **Pasha *et al.*** [15], metabolic syndrome was observed in 16 subjects [31.4%] with COPD and in 8 [15.7%] controls. The variations in the frequency of metabolic syndrome in COPD patients could perhaps be attributed to differences in the diagnostic criteria for metabolic syndrome, since our investigation was conducted using the MODIFIED NCEP ATP III criteria. However, when the IDF criteria were used for the study, the prevalence of metabolic syndrome was 8.08%, which is consistent with the findings of **Gupta *et al.*** [16], where the prevalence using NCEP ATP III and IDF criteria were 14 [15.56%] and 30 [33.33%], respectively.

The average age of the participants in the current study was 54.45 ± 9.32 years, with an age range of 40 to 78 years. Studies conducted by **Acharyya *et al.*** [17] and **Singh *et al.*** [18] reported mean ages of 60 ± 12 years and 63.2 ± 7.5 years, respectively. In our study, 51 participants [77.30%] were male, and only 15 [22.70%] were female. The male-to-female ratio differed among the populations. Our findings aligned with those of the study conducted by **Acharyya *et al.*** [17], where the males were 57 [74.02%] and females were 20 [25.97%]. Similarly, in the study by **Singh *et al.*** [18], males accounted for 60 [89.5%] and females for 7 [10.5%].

In our study, the mean Forced Expiratory Volume in the first second [FEV1] was 1.82 ± 0.7 in the study population, with a range between 0.71 and 3.31 [95% CI 1.65 to 1.99]. Most studies have assessed the Forced Vital Capacity percentage predicted [FVC% predicted] rather than the mean FEV1. However, in a study by **Yamamoto *et al.*** [19], the mean FEV1 score was measured and found to be relatively higher than the values in our study, with a mean FEV1 of 2.86 ± 0.66 L. **Borisova *et al.*** [20] noted in their study that the FEV1% predicted was 64.0 ± 2.30% for the Yakut nationality and 56.8 ± 2.69% for the Russian population.

In the study by **Funakoshi *et al.*** [21], the FEV1% predicted for GOLD stage I was 89.0 ± 7%, and for GOLD stage II~IV, it was 66.6 ± 11.5%. The FEV1% predicted values were reported as 43 ± 16% and 78.3 ± 19.1% in the

studies by **Marquis *et al.*** [9] and **Park and Larson** [22], respectively.

In our study, the mean Forced Vital Capacity [FVC] of the lungs was 2.85 ± 0.94, with a range between 1.12 to 4.91 [95% CI 2.62 to 3.09]. These results were consistent with the research by **Yamamoto *et al.*** [19], where the FVC value was reported as 2.86 ± 0.66. The FVC% predicted was measured at 108 ± 14 in our study, while other studies focused on the FVC% predicted values, which were 65.0 ± 2.45, 94.0 ± 16.6, and 79.75 ± 18.24 in the studies by **Borisova *et al.*** [20], **Paek *et al.*** [23], and **Pasha *et al.*** [15], respectively.

In the current study, the mean FEV1/FVC ratio was 0.62 ± 0.08. The range in the study population was between 0.36 to 0.70 [95% CI 0.61 to 0.64], while in the studies by **Díez-Manglano *et al.*** [24] and **Paek *et al.*** [23], the values were reported as 0.55 [0.10] and 0.58 [0.10], respectively.

The mean weight among the study subjects was 65.97 ± 11.36, with a mean height of 1.63 ± 0.08. The average BMI in the study population was 24.96 ± 5.13. Comparing with similar studies, our results were consistent with those reported in the studies by **Acharyya *et al.*** [17] and **Vujic *et al.*** [25], where the BMI values were found to be 23 ± 6 and 24.63 [5.3], respectively. However, the BMI was higher in the studies by **Breyer *et al.*** [10] and **Park and Larson** [22], with values of 26.26 ± 5.1 and 26.98 [6.42], respectively.

In our study, the mean waist circumference was 81.03 ± 8.85 cm, which was lower compared to the values reported in the studies by **Acharyya *et al.*** [17], **Vujic *et al.*** [25], **Breyer *et al.*** [10], and **Park and Larson** [22], where the waist circumference values were 87 ± 17 cm, 93.23 [11.94] cm, 98.56 [14.3] cm, and 98.98 [15.55] cm, respectively.

In the present study, the mean systolic blood pressure was 126.73 ± 14.25 mmHg. Our study results aligned with the findings of **Vujic *et al.*** [25] and **Park and Larson** [22], where the mean systolic blood pressure was reported as 125.58 [22.5] and 125.22 [20.68], respectively. However, the systolic blood pressure was notably higher in the studies by **Acharyya *et al.*** [17] and **Breyer *et al.*** [10], with values of 136 ± 23 and 138.66 ± 21.4, respectively. The mean diastolic blood pressure was found to be 82.3 ± 8.01, aligning with the values reported by **Acharyya *et al.*** [17] and **Breyer *et al.*** [10], where the values were 83 ± 10 and 82.26 ± 9.7. On the other hand, the values were lower in the study by **Vujic *et al.*** [25] and **Park and Larson** [22], with findings of 78.27 [10.29] and 65.75 [17.57], respectively.

In our study, the mean fasting blood sugar [FBS] level was 110.44 ± 14.45, lower than the values observed in the studies by **Acharyya *et al.*** [17] and **Park and Larson** [22], where the FBS levels were reported as 130 ± 65 mg/dl and 112.53 [28.20] mg/dl, respectively. The mean triglyceride level was 107.3 ± 11.85 mg/dl, notably lower compared to the values in the study by **Acharyya *et al.*** [17] and **Park and Larson** [22], where the triglyceride levels were 130 ± 77 mg/dl and 137.20 [70.70] mg/dl, respectively. The mean HDL level was found to be 47.59 ± 6.53 mg/dl, lower than the value reported in the study by **Acharyya *et al.*** [17] [43 ± 9 mg/dl] but higher than the value in the study by **Park and Larson** [22] [53.66 [17.22] mg/dl].

Our study found no significant relationship between metabolic syndrome and FEV1, FVC, and FEV1/FVC, similar to the findings of the study conducted by **Park and Larson** [22]. However, a study by **Díez-Manglano *et al.*** [24] indicated that participants with Metabolic Syndrome had better FEV1.

A marginally negative association was observed between FEV1/FVC and certain parameters, including age, weight [in kg], BMI, waist circumference, fasting blood sugar levels [mg/dl], triglyceride levels [mg/dl], and HDL levels [mg/dl]. Conversely, a marginally positive association was found between FEV1/FVC and height [in meters] and systolic and diastolic blood pressure [r value: 0.162, P value: 0.192]. In our study, waist circumference was the only parameter that demonstrated a statistically significant negative correlation with FEV1/FVC. In a study by **Acharyya *et al.*** [17], it was found that FEV1/FVC had a weak negative correlation with BMI, triglycerides, HDL, and diastolic blood pressure, and a weak positive correlation with waist circumference, fasting blood sugar, and systolic blood pressure.

Only a few studies have correlated clinical and anthropometric parameters with COPD. Our study showed a prevalence of metabolic syndrome of 6% using modified NCEP ATP III criteria and 48% using IDF criteria, the latter of which was used during the year 2006. Therefore, the variations may result from the metabolic syndrome diagnostic criteria, and a more

nationwide study is required to determine the actual prevalence of COPD in the population.

Because our study was cross-sectional, it was limited in that it was unable to draw conclusions about causality from the relationships that we found. Additionally, our study was conducted at a single center; hence, the findings cannot be generalized. We used a convenience sampling technique in our study; therefore, the current sample may not accurately reflect the population.

**Conclusion:** In our study, the rate of metabolic syndrome utilizing MODIFIED NCEP ATP III criteria was 6.06%, and using the IDF criteria was 8.8%. The frequency of metabolic syndrome in individuals with COPD may vary due to regional and racial differences and the criteria used for its diagnosis. Increasing waist circumference, FBS, triglycerides, and HDL are associated with greater severity of COPD. Abdominal obesity showed a statistically significant association with lower lung functions. No statistically significant variations were observed in pulmonary function parameters among COPD patients, both with and without metabolic syndrome. The relevance of the connection between metabolic syndrome and lung diseases, especially COPD, has brought to the forefront the importance of timely diagnosis and effective treatment of both conditions to minimize the complications and impact of metabolic syndrome in COPD. Given the prevalence of metabolic syndrome in the general population, it is crucial to continue learning more about how the two conditions affect each other in order to develop suitable management techniques.

**Financial Support and Sponsorship:** Nil.

**Conflicts of Interest:** There are no conflicts of interest.

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