



Prevalence of Metabolic Syndrome among Patients with Chronic Obstructive Pulmonary Disease: A Hospital-Based Cross-Sectional Study from Northern India

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ABSTRACT:

Background: Chronic obstructive pulmonary disease (COPD) is a systemic disorder in which metabolic syndrome (MetS) contributes substantially to cardiovascular morbidity and mortality. Data on MetS in COPD from northern India are limited.

Aims and Objective: To determine the prevalence of MetS among COPD patients using NCEP ATP III and IDF criteria, and to compare clinical, metabolic, and spirometric profiles of patients with and without MetS.

Materials and Methods: This hospital-based cross-sectional study included 183 spirometry-confirmed COPD patients aged ≥ 30 years. MetS was defined by the original 2001 NCEP ATP III criteria (fasting glucose ≥ 110 mg/dL) and IDF ethnicity-specific criteria. Continuous variables were compared using Welch's t-test or Mann-Whitney U test after Shapiro-Wilk normality testing; categorical variables using Chi-square or Fisher's exact test. Agreement between definitions was assessed by Cohen's kappa, and multivariable logistic regression identified factors independently associated with MetS.

Results: MetS was present in 77/183 (42.1%) by NCEP ATP III and 92/183 (50.3%) by IDF criteria. Seventy-two patients met both definitions, 5 NCEP ATP III only, 20 IDF only, and 86 neither (observed agreement 86.3%; $\kappa=0.73$). Patients with MetS had higher BMI (26.5 ± 4.8 vs. 21.8 ± 3.6 kg/m²), waist circumference (96.4 ± 8.9 vs. 85.6 ± 8.3 cm), blood pressure, glycaemic indices, triglycerides, and inflammatory markers, with lower HDL-C. GOLD stage and post-bronchodilator FEV1 did not differ significantly, although FEF25–75 and PEF were lower in the MetS group.

Conclusion: MetS affects nearly half of COPD patients in this cohort. Routine MetS screening should be integrated into COPD evaluation to enable early management of cardiometabolic risk.

Key words: Pulmonary disease, chronic obstructive; Metabolic syndrome; Prevalence; Spirometry; India

INTRODUCTION:

Chronic obstructive pulmonary disease (COPD) is a common, preventable, and treatable disease characterized by persistent respiratory symptoms and airflow limitation resulting from an abnormal inflammatory response of the airways and lungs to noxious particles and gases^[1,2]. It is one of the leading causes of chronic morbidity and mortality worldwide^[3]. In India, COPD is a major public health

problem among adults aged above 30 years^[4], and exposure to tobacco smoke, biomass fuel, and occupational dusts contributes substantially to the disease burden.

COPD is increasingly recognized as a systemic disease with important extrapulmonary manifestations and comorbidities, including skeletal muscle dysfunction, cardiovascular disease,



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diabetes mellitus, and metabolic abnormalities^[5]. Metabolic syndrome (MetS), a clustering of central obesity, dyslipidaemia, elevated blood pressure, and impaired glucose metabolism, is one such comorbidity and is a well-established risk factor for cardiovascular disease and type 2 diabetes mellitus^[6,7]. Several mechanisms have been proposed to link COPD and MetS, including chronic low-grade systemic inflammation, oxidative stress, hypoxia, physical inactivity, and the use of corticosteroids^[8-10].

The reported prevalence of MetS among patients with COPD varies widely across populations, depending on ethnicity, disease severity, and the diagnostic criteria applied^[11-15]. Studies from India have reported a substantial burden of MetS among COPD patients^[13-16], and a high prevalence has been observed among female COPD patients in northern India^[16]. South Asians develop cardiometabolic abnormalities at lower levels of body mass index and waist circumference than Western populations, which make the choice of diagnostic criteria particularly relevant in this population^[7].

Aim and Objectives:

Aim:

To determine the prevalence of metabolic syndrome among patients with chronic obstructive pulmonary disease attending a tertiary care hospital in northern India.

Primary objective:

1. To estimate the prevalence of metabolic syndrome among spirometry-confirmed COPD patients aged ≥ 30 years using the NCEP ATP III (2001) and IDF (ethnicity-specific) criteria.

Secondary objectives:

1. To assess the concordance between the NCEP ATP III and IDF definitions of metabolic syndrome in COPD patients.
2. To compare demographic, anthropometric, biochemical, and inflammatory parameters between COPD patients with and without metabolic syndrome.
3. To compare COPD severity (GOLD stage) and post-bronchodilator spirometric parameters between COPD patients with and without metabolic syndrome.
4. To identify factors independently associated with metabolic syndrome in COPD patients using multivariable logistic regression.

MATERIALS AND METHODS:

This hospital-based cross-sectional observational study was conducted in the Department of General Medicine, Autonomous State Medical College and allied Pt. Ram Prasad Bismil Memorial Hospital, Shahjahanpur, Uttar Pradesh, India, from September 2025 to August 2026. Participants were

recruited from the medicine outpatient department and the inpatient wards.

Adult patients aged 30 years or older with COPD diagnosed according to the Global Initiative for Chronic Obstructive Lung Disease (GOLD) recommendations (2) were included if they provided written informed consent. The diagnosis was based on a compatible clinical history, physical examination, and post-bronchodilator spirometry showing a forced expiratory volume in one second (FEV₁)/forced vital capacity (FVC) ratio < 0.70 . Patients with bronchial asthma or other chronic respiratory diseases, active pulmonary tuberculosis, interstitial lung disease, or pulmonary malignancy, and those who refused consent, were excluded.

The sample size was calculated using the formula $n = Z^2pq/d^2$, where $Z = 1.96$ for a 95% confidence level, $p = 42\%$ (expected prevalence of MetS among COPD patients based on Sahoo et al.^[15]), $q = 58\%$, and $d = 7.5\%$ absolute precision. The calculated value was 166.4 and was rounded up to 167. A 10% contingency inflation ($\times 1.10$) yielded a target sample of 184. Of the patients enrolled, 183 with complete clinical and laboratory data were included in the final analysis.

After written informed consent was obtained, demographic and clinical information was recorded in a predesigned, pretested case record form. Variables included age, sex, smoking status, pack-years among ever-smokers, biomass-fuel exposure, occupational exposure, duration of COPD, medication history including systemic corticosteroid use, coexisting illnesses, socioeconomic status, and physical activity. Height, weight, waist circumference, and body mass index (BMI) were recorded. BMI was classified as underweight (< 18.5 kg/m²), normal (18.5–22.9 kg/m²), overweight (23.0–24.9 kg/m²), or obese (≥ 25 kg/m²). Blood pressure was measured using a calibrated sphygmomanometer according to standard recommendations.

Laboratory investigations included fasting and postprandial plasma glucose, glycated haemoglobin (HbA1c), fasting lipid profile (total cholesterol, triglycerides, high-density lipoprotein cholesterol [HDL-C], and low-density lipoprotein cholesterol [LDL-C]), high-sensitivity C-reactive protein (hs-CRP), and total leukocyte count. Spirometry was performed according to American Thoracic Society/European Respiratory Society standards using a calibrated spirometer, and FEV₁, FVC, FEV₁/FVC ratio, forced expiratory flow between 25% and 75% of FVC (FEF₂₅₋₇₅), peak expiratory flow rate (PEFR), and post-bronchodilator change in FEV₁ were recorded. Disease severity was graded as GOLD stages I to IV (2). Radiological investigations were reviewed whenever clinically indicated.

MetS was diagnosed using both the NCEP ATP III^[6] and IDF^[7] criteria. For the original 2001 NCEP ATP III definition, MetS was defined by the presence of at least three of five components: waist circumference ≥ 102 cm in men or ≥ 88 cm in women; triglycerides ≥ 150 mg/dL or specific treatment; HDL-C < 40 mg/dL in men or < 50 mg/dL in women; blood pressure $\geq 130/85$ mmHg or antihypertensive treatment; and fasting plasma glucose ≥ 110 mg/dL. The original 2001 glucose threshold was retained deliberately to match the cited NCEP ATP III report. For IDF, central obesity was defined using South Asian cut-offs of waist circumference ≥ 90 cm in men or ≥ 80 cm in women and was mandatory, together with any two of elevated triglycerides (or treatment), reduced HDL-C (or treatment), elevated blood pressure (or treatment), or fasting plasma glucose ≥ 100 mg/dL/previously diagnosed diabetes.

The primary outcome was the prevalence of MetS according to the NCEP ATP III and IDF criteria. Secondary outcomes were the differences in demographic, anthropometric, biochemical, and spirometric characteristics between patients with and without MetS as defined by the NCEP ATP III criteria.

Data were entered into Microsoft Excel and analysed using IBM SPSS Statistics. Normality of continuous variables was assessed using the Shapiro–Wilk test and graphical inspection. Normally distributed variables were summarised as mean $\pm$ SD

and compared using Welch's independent-samples t-test; skewed variables were summarised as median (IQR) and compared using the Mann–Whitney U test. Categorical variables were expressed as n (%) and compared using the Chi-square test or Fisher's exact test when expected cell counts were < 5 . Pack-years were summarised only among ever-smokers. Agreement between NCEP ATP III and IDF definitions was assessed using Cohen's kappa. A multivariable binary logistic regression model was fitted for factors associated with NCEP ATP III MetS, adjusting for age, sex, ever-smoking, systemic corticosteroid use, low physical activity, BMI, COPD duration, and severe-to-very-severe COPD (GOLD III–IV). Two-sided $p < 0.05$ was considered statistically significant.

RESULTS:

A total of 183 patients with COPD were included in the analysis (Table 1). The mean age was 63.6 ± 8.3 years and 142 (77.6%) were male. Patients classified with MetS were slightly older than those without MetS (65.2 ± 8.5 vs. 62.5 ± 7.9 years, $p = 0.034$). BMI and waist circumference were both higher in the MetS group (26.5 ± 4.8 vs. 21.8 ± 3.6 kg/m² and 96.4 ± 8.9 vs. 85.6 ± 8.3 cm, respectively; both $p < 0.001$). Seventeen patients (9.3%) were underweight. Smoking status did not differ between groups, and pack-years were analysed only among ever-smokers. Biomass exposure, occupational exposure, systemic corticosteroid use, physical activity, and coexisting illnesses are also reported in Table 1.

Table 1: Baseline characteristics of the study population stratified by metabolic syndrome status (n=183)

Characteristic	Total (n=183)	MetS (n=77) present	MetS absent (n=106)	p value
Age (years)	63.6 $\pm$ 8.3	65.2 $\pm$ 8.5	62.5 $\pm$ 7.9	0.034*
Sex				0.529
Male	142 (77.6)	62 (80.5)	80 (75.5)	
Female	41 (22.4)	15 (19.5)	26 (24.5)	
GOLD stage				0.970
I	14 (7.7)	6 (7.8)	8 (7.5)	
II	52 (28.4)	22 (28.6)	30 (28.3)	
III	98 (53.6)	42 (54.5)	56 (52.8)	
IV	19 (10.4)	7 (9.1)	12 (11.3)	
BMI (kg/m ²)	23.8 $\pm$ 4.7	26.5 $\pm$ 4.8	21.8 $\pm$ 3.6	<0.001*
BMI category				<0.001*
Underweight	17 (9.3)	2 (2.6)	15 (14.2)	
Normal	72 (39.3)	18 (23.4)	54 (50.9)	
Overweight	40 (21.9)	14 (18.2)	26 (24.5)	
Obese	54 (29.5)	43 (55.8)	11 (10.4)	
Waist circumference (cm)	90.1 $\pm$ 10.1	96.4 $\pm$ 8.9	85.6 $\pm$ 8.3	<0.001*
Smoking status				0.931
Never	61 (33.3)	25 (32.5)	36 (34.0)	
Former	63 (34.4)	26 (33.8)	37 (34.9)	

Characteristic	Total (n=183)	MetS (n=77) present	MetS absent (n=106)	p value
Current	59 (32.2)	26 (33.8)	33 (31.1)	
Pack-years among ever-smokers	31.3±13.9	29.5±14.7	32.6±13.3	0.227
Duration of COPD (years)	7.0±2.9	7.5±2.8	6.7±2.9	0.048*
Biomass fuel exposure	42 (23.0)	19 (24.7)	23 (21.7)	0.768
Occupational exposure	66 (36.1)	22 (28.6)	44 (41.5)	0.100
Systemic corticosteroid use	67 (36.6)	35 (45.5)	32 (30.2)	0.050*
Physical activity				0.074
Low	96 (52.5)	48 (62.3)	48 (45.3)	
Moderate	66 (36.1)	22 (28.6)	44 (41.5)	
High	21 (11.5)	7 (9.1)	14 (13.2)	
Coexisting illnesses				<0.001*
None	92 (50.3)	8 (10.4)	84 (79.2)	
One	47 (25.7)	25 (32.5)	22 (20.8)	
Two or more	44 (24.0)	44 (57.1)	0 (0.0)	

*Statistically significant ($p<0.05$). Continuous variables were compared using Welch's t-test unless otherwise indicated; categorical variables were compared using Chi-square or Fisher's exact test as appropriate. Pack-years are reported only among ever-smokers ($n=122$).

MetS: Metabolic syndrome (NCEP ATP III criteria); SD: Standard deviation; GOLD: Global Initiative for Chronic Obstructive Lung Disease; BMI: Body mass index; COPD: Chronic obstructive pulmonary disease

Using the NCEP ATP III criteria, MetS was identified in 77 of 183 patients (42.1%), whereas 92 (50.3%) fulfilled the IDF criteria (Table 2). Seventy-two patients (39.3%) were positive by both definitions, 5 (2.7%) were NCEP-positive/IDF-negative, 20 (10.9%) were IDF-positive/NCEP-negative, and 86 (47.0%) were negative by both. Thus, 158/183 (86.3%) patients received concordant classifications, corresponding to Cohen's $\kappa=0.73$, indicating substantial agreement.

Table 2: Concordance and prevalence of metabolic syndrome by NCEP ATP III and IDF criteria (n=183)

Classification	n	% (95% CI)
NCEP ATP III	77	42.1 (34.8–49.6)
IDF (with ethnicity-specific cut-offs)	92	50.3 (42.8–57.7)
Positive by both definitions	72	39.3 (32.2–46.8)
NCEP ATP III only	5	2.7 (0.9–6.3)
IDF only	20	10.9 (6.8–16.4)
Negative by both definitions	86	47.0 (39.6–54.5)
Overall observed agreement	158	86.3%
Cohen's kappa		0.73

95% confidence intervals were calculated using the exact Clopper–Pearson method. Concordance includes both positive-by-both and negative-by-both classifications; Cohen's $\kappa=0.73$.

CI: Confidence interval; NCEP ATP III: National Cholesterol Education Program Adult Treatment Panel III; IDF: International Diabetes Federation; MetS: Metabolic syndrome

Patients with MetS had significantly greater overall and central adiposity than those without MetS, with a higher mean BMI (26.5 ± 4.8 vs. 21.8 ± 3.6 kg/m², $p<0.001$) and larger waist circumference (96.4 ± 8.9 vs. 85.6 ± 8.3 cm, $p<0.001$). The BMI-category distribution also differed significantly ($p<0.001$), with obesity present in 55.8% of the MetS group versus 10.4% of the non-MetS group. This direction of association is biologically coherent and avoids the previous discrepancy in which waist circumference increased while BMI decreased.

Among patients with MetS, elevated blood pressure was present in 71/77 (92.2%), elevated fasting glucose in 70/77 (90.9%), elevated triglycerides in 64/77 (83.1%), reduced HDL-C in 61/77 (79.2%), and the NCEP waist component in 29/77 (37.7%). Corresponding frequencies in patients without MetS were 35.8%, 14.2%, 8.5%, 17.9%, and 2.8%, respectively (all $p<0.001$). The mean number of NCEP components was 3.8 ± 0.8 in the MetS group versus 0.8 ± 0.8 in the non-MetS group ($p<0.001$).

Table 3: Frequency of individual NCEP ATP III metabolic syndrome components

Component	Total (n=183) n (%)	MetS present (n=77) n (%)	MetS absent (n=106) n (%)	p value
Elevated waist circumference (NCEP)	32 (17.5)	29 (37.7)	3 (2.8)	<0.001*
Elevated triglycerides	73 (39.9)	64 (83.1)	9 (8.5)	<0.001*
Reduced HDL-C	80 (43.7)	61 (79.2)	19 (17.9)	<0.001*
Elevated blood pressure	109 (59.6)	71 (92.2)	38 (35.8)	<0.001*
Elevated fasting glucose (≥ 110 mg/dL/known DM)	85 (46.4)	70 (90.9)	15 (14.2)	<0.001*
Number of NCEP components, mean $\pm$ SD	2.1 $\pm$ 1.7	3.8 $\pm$ 0.8	0.8 $\pm$ 0.8	<0.001*

*Statistically significant ($p < 0.05$). Categorical comparisons used Chi-square or Fisher's exact test when expected cell counts were < 5 ; component-count comparison used Welch's t-test.

MetS: Metabolic syndrome (NCEP ATP III criteria); M: Men; W: Women; HDL-C: High-density lipoprotein cholesterol; SD: Standard deviation

Patients with MetS had higher systolic and diastolic blood pressure, fasting and postprandial plasma glucose, HbA1c, triglycerides, total cholesterol, hs-CRP, and total leukocyte count, together with lower HDL-C. LDL-C did not differ significantly between groups (Table 4). Triglycerides and hs-CRP were analysed using the Mann-Whitney U test and are presented as median (IQR).

Table 4: Comparison of metabolic and laboratory parameters between patients with and without metabolic syndrome

Parameter	MetS present (n=77)	MetS absent (n=106)	p value
Blood pressure			
Systolic BP (mmHg)	138.7 $\pm$ 10.3	121.0 $\pm$ 11.0	<0.001*
Diastolic BP (mmHg)	87.8 $\pm$ 7.2	78.8 $\pm$ 7.1	<0.001*
Glucose metabolism			
Fasting plasma glucose (mg/dL)	130.3 $\pm$ 17.6	92.9 $\pm$ 16.6	<0.001*
Postprandial glucose (mg/dL)	169.7 $\pm$ 27.9	131.8 $\pm$ 28.3	<0.001*
HbA1c (%)	6.5 $\pm$ 0.6	5.4 $\pm$ 0.5	<0.001*
Lipid profile			
Total cholesterol (mg/dL)	196.8 $\pm$ 36.5	184.5 $\pm$ 35.4	0.025*
Triglycerides (mg/dL)	172.1 (154.2–189.1)	115.7 (98.5–133.8)	<0.001*
HDL-C (mg/dL)	36.9 $\pm$ 6.6	48.7 $\pm$ 8.5	<0.001*
LDL-C (mg/dL)	119.6 $\pm$ 28.3	111.4 $\pm$ 30.4	0.065
Inflammatory markers			
hs-CRP (mg/L)	4.1 (2.9–5.5)	3.1 (2.3–4.0)	<0.001*
Total leukocyte count ($\times 10^3/\mu\text{L}$)	9.8 $\pm$ 1.8	8.5 $\pm$ 1.8	<0.001*

Normally distributed variables are presented as mean $\pm$ SD and compared using Welch's t-test. Triglycerides and hs-CRP are presented as median (IQR) and compared using the Mann-Whitney U test. *Statistically significant ($p < 0.05$).

MetS: Metabolic syndrome; HbA1c: Glycated haemoglobin; HDL-C: High-density lipoprotein cholesterol; LDL-C: Low-density lipoprotein cholesterol; hs-CRP: High-sensitivity C-reactive protein; SD: Standard deviation

The distribution of GOLD stages did not differ significantly between patients with and without MetS ($p = 0.97$), with GOLD III–IV disease in 49/77 (63.6%) and 68/106 (64.2%), respectively. GOLD stage was assigned from post-bronchodilator FEV1 % predicted; all GOLD I patients had FEV1 $\geq 80\%$ predicted, and all included participants had a post-bronchodilator FEV1/FVC ratio < 0.70 .

Most post-bronchodilator spirometric parameters did not differ significantly between groups (Table 5). Mean FEV₁ was 49.72±16.86% predicted in patients with MetS and 49.20±17.21% predicted in those without MetS (p=0.84). FEV₁ (L), FVC, FEV₁/FVC ratio, and post-bronchodilator FEV₁ change were also similar. In contrast, FEF_{25–75} was lower in the MetS group (35.04±9.24% vs. 39.58±10.92% predicted, p=0.003) and PEFR was modestly lower (250.66±67.57 vs. 272.38±72.32 L/min, p=0.039).

Table 5: Post-bronchodilator spirometric parameters stratified by metabolic syndrome status

Spirometric parameter	MetS present (n=77)	MetS absent (n=106)	p value
FEV ₁ (L), post-bronchodilator	1.46±0.53	1.46±0.58	0.957
FEV ₁ (% predicted), post-bronchodilator	49.72±16.86	49.20±17.21	0.838
FVC (L), post-bronchodilator	2.71±1.02	2.67±1.15	0.800
FEV ₁ /FVC ratio (%), post-bronchodilator	54.63±7.23	55.60±6.36	0.350
FEF _{25–75} (% predicted)	35.04±9.24	39.58±10.92	0.003*
PEFR (L/min)	250.66±67.57	272.38±72.32	0.039*
Post-bronchodilator FEV ₁ change (%)	7.64±2.52	8.37±2.77	0.066

Values are mean±SD and represent post-bronchodilator measurements; groups were compared using Welch's t-test.

MetS: Metabolic syndrome; FEV₁: Forced expiratory volume in one second; FVC: Forced vital capacity; FEF_{25–75}: Forced expiratory flow between 25% and 75% of FVC; PEFR: Peak expiratory flow rate; SD: Standard deviation

In multivariable logistic regression, higher BMI (adjusted OR 1.29 per kg/m², 95% CI 1.18–1.41, p<0.001) and low physical activity (adjusted OR 2.42, 95% CI 1.17–4.98, p=0.017) remained independently associated with NCEP ATP III MetS. Age, sex, ever-smoking, systemic corticosteroid use, COPD duration, and GOLD III–IV stage were not independently significant (Table 6).

Table 6: Multivariable logistic regression for factors associated with NCEP ATP III metabolic syndrome

Variable	Adjusted OR	95% CI lower	95% CI upper	p value
Age (per year)	1.04	0.99	1.08	0.112
Male sex	1.03	0.43	2.48	0.946
Ever-smoker	1.27	0.60	2.72	0.530
Steroid use	1.52	0.72	3.17	0.269
Low activity	2.42	1.17	4.98	0.017*
BMI (per kg/m ²)	1.29	1.18	1.41	<0.001*
COPD duration (per year)	1.06	0.94	1.20	0.362
GOLD III–IV	0.87	0.41	1.84	0.721

Adjusted OR: adjusted odds ratio; model includes age, sex, ever-smoking, systemic corticosteroid use, low physical activity, BMI, COPD duration, and GOLD III–IV stage.

DISCUSSION:

In this study, MetS prevalence was 42.1% by NCEP ATP III and 50.3% by IDF criteria. The two definitions showed substantial concordance ($\kappa=0.73$), with 72 patients positive by both criteria and 86 negative by both. MetS-positive patients had higher BMI and waist circumference, adverse glycaemic and lipid profiles, and higher inflammatory markers. GOLD-stage distribution and post-bronchodilator FEV₁ were comparable, whereas FEF_{25–75} and PEFR were modestly lower in the MetS group. In the adjusted logistic model, higher BMI and low physical activity were independently associated with MetS, while age, sex, smoking, corticosteroid use, COPD duration, and GOLD III–IV stage were not independently significant in this dataset.

The prevalence represented in this study falls within the range reported in previous COPD studies. Acharyya et al. reported MetS prevalence of 44%, 46%, and 31% using NCEP ATP III, modified NCEP ATP III, and IDF definitions, respectively^[13]. Watz et al. reported an average prevalence of 47.5% in patients with chronic bronchitis/COPD^[11], while the Thai prospective study by Keeratchananont et al. reported 37.4%^[12]. These differences illustrate the influence of population characteristics, disease severity, and diagnostic criteria on reported MetS prevalence.

Patients with MetS had both a significantly larger waist circumference and a higher BMI, supporting a coherent

association between generalized and central adiposity and metabolic risk. This pattern is consistent with literature linking adiposity to metabolic abnormalities and systemic inflammation in COPD^[17-19]. Excess adipose tissue may promote chronic low-grade inflammation through cytokine-mediated pathways, insulin resistance, endothelial dysfunction, and accelerated atherosclerosis^[9,10].

Elevated blood pressure, hyperglycaemia, hypertriglyceridaemia, reduced HDL-C, and central obesity were all substantially more frequent in the MetS group. The corresponding continuous biochemical measurements moved in the expected direction, supporting agreement between component classification and laboratory values. The adjusted analysis further suggested that BMI and low physical activity were independently associated with MetS in this dataset.

COPD severity according to GOLD stage and post-bronchodilator FEV1 did not differ significantly between groups, although FEF25–75 and PEFr were lower among patients with MetS. Vujic et al. similarly examined MetS in relation to systemic inflammation and COPD characteristics [20]. Koul^[21] is an editorial commentary and is therefore cited as contextual commentary rather than as an original study reporting comparable patient-level findings.

The high prevalence of MetS observed in the present study has important implications for routine clinical practice. COPD management should extend beyond the treatment of airflow obstruction to include systematic evaluation of cardiometabolic risk factors. Incorporating simple measurements such as BMI, waist circumference, blood pressure, fasting blood glucose, and lipid profile into routine COPD assessment would facilitate early identification of high-risk individuals. Timely lifestyle modification, weight management, physical activity, and optimal treatment of diabetes, hypertension, and dyslipidaemia have the potential to reduce cardiovascular morbidity and improve overall health outcomes in this population.

A major strength of the planned analysis is the use of standardized spirometric diagnosis together with parallel assessment of NCEP ATP III and IDF definitions. Rather than assuming that use of two criteria automatically improves reliability, concordance should be quantified directly; in this dataset, observed agreement was 86.3% and Cohen's κ was 0.73. Reporting exposure variables and using multivariable regression also improves interpretability by separating crude group differences from independently associated factors.

CONCLUSION:

MetS is highly prevalent among patients with COPD in northern India, affecting nearly half of the study population.

Patients with MetS had significantly greater central adiposity, adverse metabolic profiles, and higher levels of systemic inflammatory markers, although COPD severity and FEV1 were comparable to those without MetS. These findings reinforce the concept that COPD is a systemic disease requiring comprehensive evaluation beyond pulmonary function alone. Routine screening for MetS should be incorporated into the standard assessment of COPD patients to facilitate early identification and management of cardiovascular and metabolic risk factors. Future multicentre prospective studies are warranted to determine the long-term impact of MetS on COPD outcomes and to evaluate whether integrated cardiometabolic interventions can improve morbidity and survival.

The study protocol was approved by the Institutional Ethics Committee of Autonomous State Medical College, Shahjahanpur, Uttar Pradesh (Certificate No. Principal/Ethics committee/2025/1689 dated September 04, 2025) before commencement of the study. Written informed consent was obtained from all participants prior to enrolment. The procedures followed were in accordance with the ethical standards of the Institutional Ethics Committee and with the Helsinki Declaration of 1975, as revised and participant confidentiality was maintained throughout the study.

DECLARATIONS:

Ethical Approval: The study protocol was approved by the Institutional Ethics Committee of Autonomous State Medical College, Shahjahanpur, Uttar Pradesh (Certificate No. Principal/Ethics committee/2025/1689 dated September 04, 2025) before commencement of the study. Written informed consent was obtained from all participants prior to enrolment. The procedures followed were in accordance with the ethical standards of the Institutional Ethics Committee and with the Helsinki Declaration of 1975, as revised and participant confidentiality was maintained throughout the study.

Informed Consent: Informed consent was obtained from all participants prior to their inclusion in the study. Participants were informed that their data would be kept confidential and used solely for research purposes.

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Conflict of Interest: The authors declare that there is no conflict of interest.

Data availability statement: The dataset presented in this study is available on request from the corresponding author.

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REFERENCES:

1. Barnes PJ, Shapiro SD, Pauwels RA. Chronic obstructive pulmonary disease: molecular and cellular mechanisms. *Eur Respir J*. 2003 Oct;22(4):672-88. <https://doi.org/10.1183/09031936.03.00040703>
2. Venkatesan P. GOLD COPD report: 2025 update. *Lancet Respir Med*. 2025 Jan;13(1):e7-e8. [https://doi.org/10.1016/s2213-2600\(24\)00413-2](https://doi.org/10.1016/s2213-2600(24)00413-2)
3. World Health Organization. Chronic obstructive pulmonary disease (COPD) [online]. Geneva: WHO; 2026 Jun 10 [cited 2026 Sep 23]. [https://www.who.int/news-room/fact-sheets/detail/chronic-obstructive-pulmonary-disease-\(copd\)](https://www.who.int/news-room/fact-sheets/detail/chronic-obstructive-pulmonary-disease-(copd))
4. Verma A, Gudi N, Yadav UN, Roy MP, Mahmood A, Nagaraja R, Nayak P. Prevalence of COPD among population above 30 years in India: A systematic review and meta-analysis. *J Glob Health*. 2021 Aug 21;11:04038. <https://pubmed.ncbi.nlm.nih.gov/34484706/>
5. Agustí AG, Noguera A, Sauleda J, Sala E, Pons J, Busquets X. Systemic effects of chronic obstructive pulmonary disease. *Eur Respir J*. 2003 Feb;21(2):347-60. <https://doi.org/10.1183/09031936.03.00405703>
6. Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults. Executive Summary of The Third Report of The National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, And Treatment of High Blood Cholesterol In Adults (Adult Treatment Panel III). *JAMA*. 2001 May 16;285(19):2486-97. <https://doi.org/10.1001/jama.285.19.2486>
7. Alberti KG, Zimmet P, Shaw J. Metabolic syndrome--a new world-wide definition. A Consensus Statement from the International Diabetes Federation. *Diabet Med*. 2006 May;23(5):469-80. <https://doi.org/10.1111/j.1464-5491.2006.01858.x>
8. Naik D, Joshi A, Paul TV, Thomas N. Chronic obstructive pulmonary disease and the metabolic syndrome: Consequences of a dual threat. *Indian J Endocrinol Metab*. 2014 Sep;18(5):608-16. <https://doi.org/10.4103/2230-8210.139212>
9. Baffi CW, Wood L, Winnica D, Strollo PJ Jr, Gladwin MT, Que LG, Holguin F. Metabolic Syndrome and the Lung. *Chest*. 2016 Jun;149(6):1525-34. <https://doi.org/10.1016/j.chest.2015.12.034>
10. Fekete M, Szollosi G, Tarantini S, Lehocski A, Nemeth AN, Bodola C, Varga L, Varga JT. Metabolic syndrome in patients with COPD: Causes and pathophysiological consequences. *Physiol Int*. 2022 Mar 3;109(1):90-105. <https://doi.org/10.1556/2060.2022.00164>
11. Watz H, Waschki B, Kirsten A, Müller KC, Kretschmar G, Meyer T, Holz O, Magnussen H. The metabolic syndrome in patients with chronic bronchitis and COPD: frequency and associated consequences for systemic inflammation and physical inactivity. *Chest*. 2009 Oct;136(4):1039-1046. <https://doi.org/10.1378/chest.09-0393>
12. Keeratchananont W, Kaenmuang P, Geater SL, Manoret P, Thanapattaraborisuth B. Prevalence, associated factors, and clinical consequences of metabolic syndrome in chronic obstructive pulmonary disease patients: a 5-year prospective observational study. *Ther Adv Respir Dis*. 2023 Jan-Dec;17:17534666231167342. <https://doi.org/10.1177/17534666231167342>
13. Acharyya A, Shahjahan MD, Mesbah FB, Dey SK, Ali L. Association of metabolic syndrome with chronic obstructive pulmonary disease in an Indian population. *Lung India*. 2016 Jul-Aug;33(4):385-90. <https://pubmed.ncbi.nlm.nih.gov/27578930/>
14. Priyadarshini N, Renusha RC, Reshma S, Sindhuri Sai M, Koushik Muthu RM, Rajanandh MG. Prevalence of metabolic syndrome in patients with chronic obstructive pulmonary disease: An observational study in South Indians. *Diabetes Metab Syndr*. 2020 Jul-Aug;14(4):503-507. <https://doi.org/10.1016/j.dsx.2020.04.042>
15. Sahoo KC, Subhankar S, Mohanta PC, Jagaty SK, Dutta P, Pothal S. Prevalence of metabolic syndrome in chronic obstructive pulmonary disease

- and its correlation with severity of disease. *J Family Med Prim Care*. 2022 May;11(5):2094-2098. <https://pubmed.ncbi.nlm.nih.gov/35800553/>
16. Roy R, Gautam AK, Singh NP, Kumar A. Metabolic Syndrome and Its Correlates Among Female Chronic Obstructive Pulmonary Disease Patients at a Rural Tertiary Health Care Center in Northern India. *Cureus*. 2022 Aug 31;14(8):e28611. <https://doi.org/10.7759/cureus.28611>
 17. Cecere LM, Littman AJ, Slatore CG, Udris EM, Bryson CL, Boyko EJ, Pierson DJ, Au DH. Obesity and COPD: associated symptoms, health-related quality of life, and medication use. *COPD*. 2011 Aug;8(4):275-84. <https://doi.org/10.3109/15412555.2011.586660>
 18. Eisner MD, Blanc PD, Sidney S, Yelin EH, Lathon PV, Katz PP, Tolstykh I, Ackerson L, Iribarren C. Body composition and functional limitation in COPD. *Respir Res*. 2007 Jan 29;8(1):7. <https://doi.org/10.1186/1465-9921-8-7>
 19. Verberne LDM, Leemrijse CJ, Swinkels ICS, van Dijk CE, de Bakker DH, Nielen MMJ. Overweight in patients with chronic obstructive pulmonary disease needs more attention: a cross-sectional study in general practice. *NPJ Prim Care Respir Med*. 2017 Nov 22;27(1):63. <https://doi.org/10.1038/s41533-017-0065-3>
 20. Vujic T, Nagorni O, Maric G, Popovic L, Jankovic J. Metabolic syndrome in patients with chronic obstructive pulmonary disease: frequency and relationship with systemic inflammation. *Hippokratia*. 2016 Apr-Jun;20(2):110-114. <https://pmc.ncbi.nlm.nih.gov/articles/PMC5388510/>
 21. Koul PA. Metabolic syndrome and chronic obstructive pulmonary disease. *Lung India*. 2016 Jul-Aug;33(4):359-61. <https://pubmed.ncbi.nlm.nih.gov/27578925/>