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METABOLIC SYNDROME AND EXACERBATION BURDEN IN CHRONIC OBSTRUCTIVE PULMONARY DISEASE: A HOSPITAL-BASED OBSERVATIONAL STUDY

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ABSTRACT **Background:** Chronic obstructive pulmonary disease (COPD) is increasingly recognised as a systemic disorder, with cardiometabolic comorbidities contributing to symptom burden and adverse outcomes. Metabolic syndrome represents a cluster of modifiable cardiovascular risk factors that may influence exacerbation risk in COPD. Objective: To evaluate the prevalence of metabolic syndrome in patients with COPD and assess its association with exacerbation status, GOLD class and selected cardiometabolic abnormalities. **Methods:** This hospital-based observational and comparative study included 200 patients with COPD. Demographic profile, exacerbation status, GOLD class, BMI category, blood pressure, fasting blood sugar and fasting lipid profile were recorded. Metabolic syndrome status was assigned after assessment of recorded anthropometric, blood pressure, fasting glucose and lipid components. Categorical variables were summarised as number and percentage. Associations were analysed using the chi-square test, and unadjusted odds ratios were calculated for selected factors. **Results:** Metabolic syndrome was present in 98 patients (49.0%). COPD exacerbation was documented in 140 patients (70.0%). Metabolic syndrome was significantly more frequent among patients with exacerbation than those without exacerbation (62.1% versus 18.3%; p<0.001). Metabolic syndrome was also more frequent among males (56.7%) than females (35.6%; p=0.006). GOLD class distribution did not differ significantly according to metabolic syndrome status (p=0.755). Among metabolic abnormalities, blood pressure above the normal category (79.6% versus 64.7%; p=0.029) and low HDL cholesterol (53.1% versus 27.5%; p<0.001) were significantly more frequent in patients with metabolic syndrome. **Conclusion:** Nearly half of the COPD patients had metabolic syndrome. Exacerbation status showed the strongest association with metabolic syndrome, while low HDL cholesterol and raised blood pressure were the most discriminating cardiometabolic abnormalities. Routine cardiometabolic evaluation may help identify COPD patients who require integrated respiratory and cardiovascular risk management.

KEYWORDS : Chronic Obstructive Pulmonary Disease; Metabolic Syndrome; COPD Exacerbation; GOLD Class; HDL Cholesterol; Cardiometabolic Risk

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is characterised by persistent respiratory symptoms and airflow limitation due to airway and alveolar abnormalities, usually related to long-term exposure to noxious particles or gases [1,2]. Although COPD is diagnosed through respiratory assessment, it is not limited to the lungs. Systemic inflammation, skeletal muscle dysfunction, nutritional abnormalities and cardiovascular comorbidities are recognised components of the clinical spectrum of COPD [3]. Contemporary GOLD-based assessment therefore encourages evaluation of symptoms, exacerbation risk and comorbid conditions rather than airflow obstruction alone [4].

Metabolic syndrome is a constellation of central adiposity, hypertension, dysglycaemia, hypertriglyceridaemia and reduced high-density lipoprotein (HDL) cholesterol. It is clinically important because it increases the risk of cardiovascular disease and type 2 diabetes [5,6]. COPD and metabolic syndrome share several risk pathways, including smoking, physical inactivity, systemic inflammation, oxidative stress and obesity-related adipose tissue inflammation. The coexistence of these conditions may increase the burden of dyspnoea, reduce exercise tolerance and complicate long-term management [3,7].

In routine pulmonary practice, exacerbation history and cardiometabolic risk are often assessed separately. This can lead to under-recognition of metabolic syndrome, particularly when its components are mild or asymptomatic. A focused evaluation of blood pressure, fasting glucose and lipid profile in COPD patients may therefore identify an important modifiable risk cluster before overt cardiovascular events occur.

Previous studies have reported a substantial prevalence of metabolic syndrome among COPD patients, but the pattern of association with exacerbation status and specific metabolic abnormalities has varied across populations [8-10]. Identifying the metabolic features most strongly associated with COPD exacerbation burden may help clinicians move from isolated pulmonary treatment to integrated cardiopulmonary care. The present study was undertaken to determine the prevalence of metabolic syndrome in COPD and to examine its relationship with exacerbation status, GOLD class, blood pressure and selected biochemical abnormalities.

MATERIALS AND METHODS

This hospital-based observational and comparative study was conducted in the Department of Respiratory Medicine, Index Medical College Hospital and Research Centre, Indore, India. Institutional Ethics Committee approval was obtained before enrolment, and written informed consent was obtained from all participants.

A total of 200 patients with diagnosed COPD were included. Eligible patients were aged more than 40 years, had valid consent and had COPD classified according to GOLD criteria. Patients with active pulmonary tuberculosis, chronic oxygen therapy, history of asthma or other chronic respiratory diseases, malignancy, previous lung surgery, severe heart failure, severe liver failure, severe kidney failure, acute coronary syndrome or acute cerebrovascular event were excluded.

All patients underwent detailed history taking, clinical examination and review of available hospital records. COPD exacerbation status was recorded. Physiological assessment included post-bronchodilator FEV1 percentage, and patients were categorised by GOLD class. Nutritional status was assessed by height and weight with BMI categorisation. Blood pressure was measured and classified as normal, elevated, hypertension stage 1 or hypertension stage 2. Blood samples were obtained after a 12-hour fast for fasting blood sugar and lipid profile, including total cholesterol, triglycerides, LDL cholesterol and HDL cholesterol. Chest radiography, pulmonary function testing, ECG, anthropometric assessment and biochemical investigations were performed as part of the evaluation.

Metabolic syndrome status was assigned after assessment of recorded anthropometric, blood pressure, fasting glucose and lipid profile components. For component-wise analysis, blood pressure above normal included elevated blood pressure and hypertension stages 1 and 2. Raised fasting blood sugar was defined as >=100 mg/dL, raised total cholesterol as >=200 mg/dL, raised LDL cholesterol as >=100 mg/dL, raised triglycerides as >=150 mg/dL, and low HDL cholesterol as <40 mg/dL in males and <50 mg/dL in females.

Continuous variables were expressed as mean and standard deviation when appropriate. Categorical variables were summarised as number and percentage. Associations between metabolic syndrome and categorical clinical variables were assessed using the chi-square test. Unadjusted odds ratios with 95% confidence intervals were calculated

for selected factors. A p value below 0.05 was considered statistically significant.

RESULTS

A total of 200 patients with COPD were analysed. The mean age was 64.64 ± 14.66 years. There were 127 males (63.5%) and 73 females (36.5%). Metabolic syndrome was present in 98 patients (49.0%), while 102 patients (51.0%) did not meet the criteria. COPD exacerbation was documented in 140 patients (70.0%). GOLD class A was the most frequent category, followed by class B, class D and class C. The baseline demographic, COPD-related and cardiometabolic profile is shown in Table 1.

Table 1. Baseline Demographic, COPD-related and Cardio-metabolic Profile of the Study Population (n=200)

Characteristic	Category	n (%)
Age group	<=50 years	32 (16.0)
	51-60 years	43 (21.5)
	61-70 years	66 (33.0)
	>70 years	59 (29.5)
Sex	Male	127 (63.5)
	Female	73 (36.5)
COPD exacerbation	Yes	140 (70.0)
	No	60 (30.0)
GOLD class	A	64 (32.0)
	B	49 (24.5)
	C	43 (21.5)
	D	44 (22.0)
BMI category	Underweight	6 (3.0)
	Normal	92 (46.0)
	Overweight/Obese	102 (51.0)
Blood pressure category	Normal	56 (28.0)
	Elevated	55 (27.5)
	Hypertension Stage 1	51 (25.5)
	Hypertension Stage 2	38 (19.0)
Metabolic syndrome	Positive	98 (49.0)
	Negative	102 (51.0)

The distribution of metabolic syndrome according to sex, COPD exacerbation status, GOLD class and blood pressure category is shown in Table 2. Metabolic syndrome was significantly more frequent among males than females (56.7% versus 35.6%; p=0.006). A strong association was observed between COPD exacerbation and metabolic syndrome. Among patients with exacerbation, 87 of 140 (62.1%) had metabolic syndrome compared with 11 of 60 (18.3%) patients without exacerbation (p<0.001). GOLD class distribution was not significantly different between metabolic syndrome-positive and metabolic syndrome-negative patients (p=0.755). Blood pressure category showed a higher proportion of metabolic syndrome among patients with elevated blood pressure and hypertension, but the overall comparison did not reach statistical significance (p=0.102).

Table 2. Distribution of Metabolic Syndrome According to Demographic and COPD-related Characteristics

Variable	Category	MetS positive n (%)	MetS negative n (%)	Total	p value
Sex	Male	72 (56.7)	55 (43.3)	127	0.006
	Female	26 (35.6)	47 (64.4)	73	
COPD exacer-bation	Yes	87 (62.1)	53 (37.9)	140	<0.001
	No	11 (18.3)	49 (81.7)	60	
GOLD class	A	34 (53.1)	30 (46.9)	64	0.755
	B	21 (42.9)	28 (57.1)	49	
	C	21 (48.8)	22 (51.2)	43	
	D	22 (50.0)	22 (50.0)	44	
Blood pressure category	Normal	20 (35.7)	36 (64.3)	56	0.102
	Elevated	28 (50.9)	27 (49.1)	55	
	Hyper-tension Stage 1	30 (58.8)	21 (41.2)	51	
	Hyper-tension Stage 2	20 (52.6)	18 (47.4)	38	

MetS: metabolic syndrome. P values were calculated using the chi-square test.

Selected cardiometabolic abnormalities are summarised in Table 3. Blood pressure above the normal category was significantly more frequent in patients with metabolic syndrome than in those without metabolic syndrome (79.6% versus 64.7%; p=0.029). Low HDL cholesterol was also significantly more frequent in the metabolic syndrome-positive group (53.1% versus 27.5%; p<0.001). Raised fasting blood sugar, raised total cholesterol, raised LDL cholesterol and raised triglycerides were common in both groups and were not significantly different.

Table 3. Distribution of Selected Metabolic Abnormalities According to Metabolic Syndrome Status

Metabolic abnormality	MetS positive (n=98) n (%)	MetS negative (n=102) n (%)	p value
BP above normal	78 (79.6)	66 (64.7)	0.029
Raised fasting blood sugar (>=100 mg/dL)	67 (68.4)	70 (68.6)	1.000
Raised total cholesterol (>=200 mg/dL)	59 (60.2)	55 (53.9)	0.451
Raised LDL (>=100 mg/dL)	49 (50.0)	58 (56.9)	0.406
Raised triglycerides (>=150 mg/dL)	47 (48.0)	49 (48.0)	1.000
Low HDL (<40 mg/dL in males; <50 mg/dL in females)	52 (53.1)	28 (27.5)	<0.001

MetS: metabolic syndrome; HDL: high-density lipoprotein; LDL: low-density lipoprotein; BP: blood pressure. P values were calculated using the chi-square test.

In the unadjusted effect-size analysis, COPD exacerbation had the strongest association with metabolic syndrome, followed by low HDL cholesterol, male sex and blood pressure above the normal category (Figure 1). The overall frequency of selected metabolic abnormalities is shown in Figure 2. Blood pressure above normal and raised fasting blood sugar were the most frequent abnormalities, followed by raised total cholesterol, raised LDL cholesterol, raised triglycerides and low HDL cholesterol.

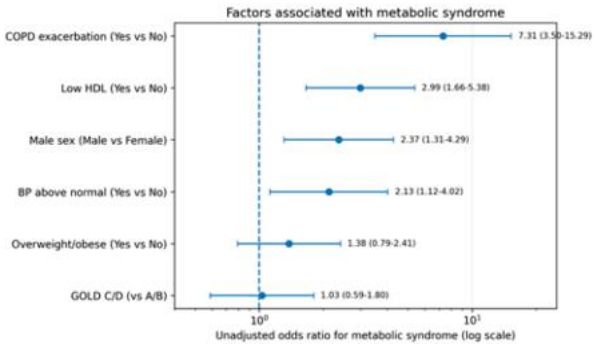

Figure 1. Unadjusted Odds Ratios for Metabolic Syndrome According to Selected Clinical and Cardiometabolic Factors.

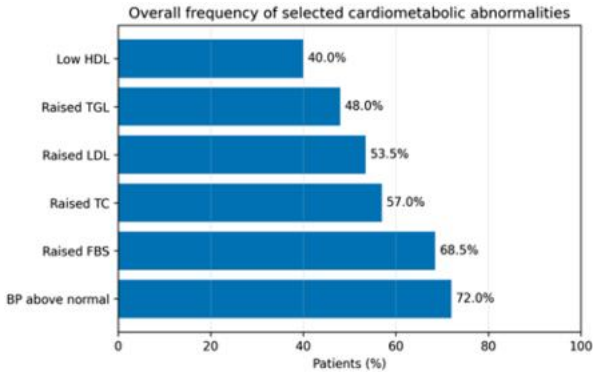

Figure 2. Overall Frequency of Selected Cardiometabolic Abnormalities in COPD Patients.

DISCUSSION

The present study found that metabolic syndrome was present in nearly half of patients with COPD. The main clinical signal was the strong association between metabolic syndrome and COPD exacerbation status. More than three-fifths of patients with exacerbation had metabolic syndrome, whereas fewer than one-fifth of non-

exacerbators had metabolic syndrome. This pattern supports the concept that metabolic health is not merely a parallel comorbidity in COPD but may identify a subgroup with higher clinical instability.

The prevalence of metabolic syndrome in this cohort is comparable to earlier Indian COPD studies. Tiwari et al. reported metabolic syndrome in 46.8% of COPD cases and observed a significant relationship with acute exacerbations [8]. Dogra et al. found metabolic syndrome in 45% of COPD patients and highlighted inflammatory and insulin-resistance markers as potential screening tools [9]. Dave et al. also reported a higher burden of metabolic syndrome components among COPD patients compared with controls [10]. Kumar et al. similarly reported metabolic syndrome as a relevant comorbidity in North Indian COPD patients, supporting the need for comprehensive metabolic screening in this population [11]. These findings are consistent with the present prevalence of 49.0% and support routine metabolic screening in COPD clinics.

The association between metabolic syndrome and exacerbation is clinically important. Exacerbations are major drivers of hospitalisation, quality-of-life deterioration and disease progression in COPD. Mekov et al. observed that metabolic syndrome in hospitalised COPD patients was associated with poorer symptom domains and higher exacerbation frequency [12]. Systemic inflammation, endothelial dysfunction, dysglycaemia and dyslipidaemia may provide plausible biological links between cardiometabolic disturbance and exacerbation-prone COPD. The cross-sectional design does not prove causality, but the magnitude of association in the current analysis suggests that metabolic syndrome should be considered during risk assessment.

Among individual abnormalities, low HDL cholesterol and blood pressure above normal were the most discriminating features. Low HDL remained significantly more frequent in patients with metabolic syndrome, while raised triglycerides and fasting glucose were frequent in both groups. This may reflect the high background prevalence of metabolic abnormalities in COPD patients attending tertiary care. Ahmed et al. reported that accumulation of metabolic syndrome components was negatively associated with lung function parameters [13], and Meher et al. emphasised systemic inflammation as a link between COPD and metabolic syndrome [14]. The present pattern adds practical relevance by identifying low HDL and raised blood pressure as easily measurable markers that may prompt fuller metabolic assessment.

GOLD class was not significantly associated with metabolic syndrome in this analysis. This finding indicates that metabolic syndrome may not simply follow the categorical distribution of COPD severity groups. It may instead represent a systemic phenotype that overlaps with exacerbation burden, inflammatory activity, nutritional status and vascular risk. Population-based data from Viglino et al. also suggest that the relationship between COPD and metabolic profile may differ according to disease phenotype, severity and study setting [15]. Similarly, patients with overlap syndromes such as COPD with obstructive sleep apnoea have been reported to show a high cardiometabolic burden, highlighting that COPD phenotypes may carry different metabolic risks [16]. Therefore, absence of a GOLD-class association should not reduce the importance of metabolic screening.

The study has direct clinical implications. COPD management frequently focuses on bronchodilation, inhaled therapy and prevention of respiratory exacerbations; however, coexistent metabolic syndrome may increase future cardiovascular risk and complicate recovery after exacerbations. Screening for blood pressure, fasting glucose and lipid abnormalities is simple, inexpensive and feasible in routine pulmonary practice. Early identification of metabolic syndrome can guide lifestyle counselling, cardiovascular risk modification and coordinated care with internal medicine or cardiology services. This is particularly relevant in tertiary-care COPD populations, where multimorbidity is common and respiratory symptoms may mask cardiometabolic disease.

Limitations

The cross-sectional design can demonstrate association but cannot establish temporal or causal relationships between metabolic syndrome and COPD exacerbation. Data on inflammatory biomarkers, medication exposure, smoking burden, physical activity and longitudinal exacerbation frequency were not included in the present analysis. Component-wise metabolic syndrome classification was based on recorded clinical and biochemical variables, and residual confounding cannot be excluded. Larger multicentre longitudinal studies are required to confirm whether active management of metabolic syndrome reduces COPD exacerbations or improves long-term outcomes.

CONCLUSION

Metabolic syndrome was present in 49.0% of patients with COPD. COPD exacerbation status showed the strongest association with metabolic syndrome, while low HDL cholesterol and blood pressure above the normal category were the most discriminating cardiometabolic abnormalities. GOLD class was not significantly associated with metabolic syndrome, suggesting that metabolic syndrome should be evaluated as an independent systemic comorbidity rather than inferred from COPD class alone. Routine cardiometabolic assessment may help identify high-risk COPD patients who require integrated respiratory and cardiovascular risk management.

Declarations

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