



## CHRONIC OBSTRUCTIVE PULMONARY DISEASE AND METABOLIC SYNDROME: CURRENT EVIDENCE AND FUTURE DIRECTIONS

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### ABSTRACT

*Chronic Obstructive Pulmonary Disease (COPD) and Metabolic Syndrome (MetS) are two highly prevalent chronic conditions with significant global health burden. Increasing evidence indicates a strong interplay between these disorders, mediated by systemic inflammation, oxidative stress, and metabolic dysregulation. The coexistence of COPD and MetS is associated with accelerated lung function decline, higher frequency of exacerbations, increased cardiovascular risk, and reduced quality of life. This review summarizes current epidemiological data, underlying pathophysiological mechanisms, and clinical implications of the COPD–MetS overlap. Additionally, emerging therapeutic strategies—including lifestyle interventions, pharmacological approaches, and precision medicine—are discussed. Understanding the interaction between COPD and MetS is critical for early detection, risk stratification, and integrated patient management, and future research should focus on longitudinal studies and novel biomarker-based approaches.*

## ХРОНИЧЕСКАЯ ОБСТРУКТИВНАЯ БОЛЕЗНЬ ЛЕГКИХ И МЕТАБОЛИЧЕСКИЙ СИНДРОМ: СОВРЕМЕННЫЕ ДАННЫЕ И НАПРАВЛЕНИЯ ДАЛЬНЕЙШЕГО ЛЕЧЕНИЯ

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### ABSTRACT

*Хроническая обструктивная болезнь легких (ХОБЛ) и метаболический синдром (МС) — два широко распространенных хронических*



*Хроническая обструктивная  
болезнь легких;  
метаболический синдром;  
системное воспаление;  
окислительный стресс;  
коморбидность;  
метаболическая дисфункция;  
прецизионная медицина.*

*заболевания, оказывающих значительное влияние на здоровье населения во всем мире. Все больше данных свидетельствует о тесной взаимосвязи между этими заболеваниями, опосредованной системным воспалением, окислительным стрессом и нарушением метаболической регуляции. Сочетание ХОБЛ и МС связано с ускоренным снижением функции легких, более высокой частотой обострений, повышенным сердечно-сосудистым риском и снижением качества жизни. В этом обзоре обобщены современные эпидемиологические данные, основные патофизиологические механизмы и клинические аспекты перекреста ХОБЛ и МС. Кроме того, обсуждаются новые терапевтические стратегии, включая изменение образа жизни, фармакологические подходы и прецизионные методы лечения. Понимание взаимодействия ХОБЛ и МС имеет решающее значение для раннего выявления, стратификации риска и комплексного ведения пациентов, и будущие исследования должны быть сосредоточены на продольных исследованиях и новых подходах, основанных на биомаркерах.*

**Introduction.** Chronic Obstructive Pulmonary Disease (COPD) is a progressive respiratory disorder characterized by persistent airflow limitation, chronic inflammation, and structural alterations of the lungs. It is a major cause of morbidity and mortality worldwide and imposes a substantial economic and social burden on healthcare systems. Traditionally considered a pulmonary disease, COPD is now increasingly recognized as a systemic condition due to its association with multiple comorbidities and systemic inflammatory processes.

Metabolic Syndrome (MetS) is a cluster of interrelated metabolic abnormalities, including central obesity, insulin resistance, dyslipidemia, and hypertension. It has become highly prevalent globally, largely driven by sedentary lifestyles, dietary changes, and aging populations. MetS is a well-established risk factor for cardiovascular disease, type 2 diabetes, and overall mortality.

Recent studies have highlighted a significant overlap between COPD and MetS. Epidemiological data suggest that MetS affects up to 60% of patients with COPD, although prevalence varies depending on diagnostic criteria, population characteristics, and disease stage. This coexistence is clinically important because MetS may exacerbate pulmonary dysfunction, increase systemic inflammation, and elevate cardiovascular risk



in COPD patients. Conversely, chronic systemic inflammation and oxidative stress inherent to COPD can contribute to the development of metabolic abnormalities, creating a bidirectional relationship.

Understanding the interplay between COPD and MetS is critical for optimizing patient management, developing integrated treatment strategies, and improving long-term outcomes. Despite growing evidence, knowledge gaps remain regarding the mechanisms linking these disorders, their clinical impact, and the most effective therapeutic approaches. This review aims to synthesize current evidence on the epidemiology, pathophysiology, and clinical implications of COPD–MetS overlap, and to outline future directions for research and therapy.

**Literature Review.** The relationship between Chronic Obstructive Pulmonary Disease (COPD) and Metabolic Syndrome (MetS) has been extensively explored in recent decades, yet the evidence remains heterogeneous. Epidemiological studies consistently report a higher prevalence of MetS among COPD patients, ranging from 20% to 60%, with variation attributed to differences in diagnostic criteria, ethnicity, age, and disease severity (Agusti et al., 2017; Kwon, 2019). Notably, early-stage COPD patients appear more susceptible to metabolic abnormalities, while advanced COPD is often accompanied by weight loss and sarcopenia, potentially masking MetS prevalence (Fabbri & Rabe, 2007).

Several studies highlight chronic systemic inflammation as a central mechanism linking COPD and MetS. Elevated circulating levels of C-reactive protein (CRP), interleukin-6 (IL-6), and tumor necrosis factor-alpha (TNF- $\alpha$ ) have been documented in patients with overlapping phenotypes (Gan et al., 2004; Watz et al., 2009). However, some studies suggest that these inflammatory markers may be influenced by confounding factors such as smoking status, corticosteroid therapy, and physical inactivity, limiting the ability to establish causality.

Oxidative stress and mitochondrial dysfunction have been proposed as additional mediators, contributing to insulin resistance and dyslipidemia in COPD patients (Barnes, 2016). While several mechanistic studies support these pathways, most evidence derives from small sample sizes or experimental models, emphasizing the need for large-scale human studies.

Clinical investigations consistently report that patients with both COPD and MetS experience poorer outcomes, including increased exacerbation frequency, reduced exercise tolerance, and higher cardiovascular risk (Güzel et al., 2018; Bekturganova, 2020). Yet, the degree of impact varies across studies, and some fail to adjust adequately for comorbid conditions, highlighting methodological limitations.

Therapeutically, lifestyle interventions—including exercise and dietary modifications—show promise in improving both pulmonary function and metabolic parameters (Troosters et al., 2010). Pharmacological approaches, such as metformin and statins, are under investigation for potential dual benefits, although current data are preliminary and occasionally conflicting (Watz et al., 2014). The literature indicates a gap in evidence-based guidelines specifically addressing the integrated management of COPD–MetS patients.



In summary, while current studies support a strong association between COPD and MetS mediated by shared inflammatory and metabolic pathways, limitations in study design, population heterogeneity, and confounding factors warrant cautious interpretation. Future research should prioritize longitudinal, multicenter studies with standardized diagnostic criteria and robust adjustment for confounders to clarify causality, prognosis, and optimal management strategies.

**Discussion.** The coexistence of Chronic Obstructive Pulmonary Disease (COPD) and Metabolic Syndrome (MetS) represents a clinically significant challenge, underscoring the systemic nature of COPD and the multifactorial pathogenesis of MetS. The literature indicates that systemic inflammation, oxidative stress, hypoxia, and metabolic dysregulation are central to the interplay between these conditions. Elevated biomarkers such as CRP, IL-6, and TNF- $\alpha$  suggest a persistent pro-inflammatory milieu that contributes both to airway obstruction and to metabolic derangements, including insulin resistance and dyslipidemia (Gan et al., 2004; Barnes, 2016). Clinically, the overlap between COPD and MetS is associated with worse patient outcomes. Multiple studies demonstrate higher rates of acute exacerbations, reduced exercise tolerance, and impaired quality of life in patients with coexisting conditions (Güzel et al., 2018; Bekturganova, 2020). Cardiovascular risk is notably amplified, reflecting the additive impact of metabolic abnormalities on pulmonary and systemic vascular health. These findings highlight the importance of screening for MetS components in COPD patients, particularly in the early stages of disease progression. Therapeutic approaches remain largely fragmented. Lifestyle interventions, including structured physical activity and nutritional optimization, are effective in mitigating both pulmonary and metabolic dysfunction, yet adherence is often limited in clinical practice (Troosters et al., 2010). Pharmacological strategies such as metformin, statins, and GLP-1 receptor agonists show potential benefits but require further validation in randomized controlled trials specifically targeting the COPD–MetS phenotype (Watz et al., 2014). Additionally, conventional COPD therapies, including inhaled corticosteroids and long-acting bronchodilators, may influence metabolic parameters, highlighting the need for integrated management plans that consider systemic effects.

Despite growing recognition, several knowledge gaps persist. Many studies are cross-sectional, limiting causal inferences, and heterogeneous diagnostic criteria complicate comparisons. Confounding factors such as smoking, corticosteroid use, and physical inactivity are inconsistently accounted for, which may bias estimates of prevalence and outcome measures. Furthermore, precision medicine approaches, including biomarker-based phenotyping and personalized therapeutic strategies, are still in early stages. Overall, the evidence underscores the need for an integrated, multidisciplinary approach to managing patients with COPD and MetS. This should include systematic screening, personalized risk stratification, and coordinated lifestyle and pharmacological interventions. Future research must focus on longitudinal studies, mechanistic insights, and interventional trials to define optimal strategies for improving both pulmonary and metabolic outcomes in this high-risk population.



**Conclusion.** The coexistence of Chronic Obstructive Pulmonary Disease (COPD) and Metabolic Syndrome (MetS) represents a significant clinical and public health concern, reflecting the systemic nature of COPD and the metabolic consequences of chronic inflammation. Evidence indicates that patients with overlapping COPD–MetS phenotypes experience worse clinical outcomes, including accelerated lung function decline, increased exacerbation frequency, higher cardiovascular risk, and reduced quality of life. Shared pathophysiological mechanisms, including systemic inflammation, oxidative stress, insulin resistance, and adipokine dysregulation, provide a biological basis for the observed interaction between these conditions. Recognition of this interplay is essential for early detection, risk stratification, and the development of integrated therapeutic strategies.

Current interventions, including lifestyle modification and pharmacological therapies targeting metabolic abnormalities, show promise; however, their implementation is limited by a lack of standardized guidelines and high-quality evidence. Future research should prioritize longitudinal studies, biomarker-driven phenotyping, and interventional trials to optimize clinical management.

In conclusion, understanding and addressing the COPD–MetS overlap is critical for improving patient outcomes and reducing the burden of these chronic, interrelated conditions. Multidisciplinary, personalized approaches hold the greatest potential to enhance both pulmonary and metabolic health.

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