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The prevalence of metabolic syndrome among patients with chronic obstructive pulmonary disease

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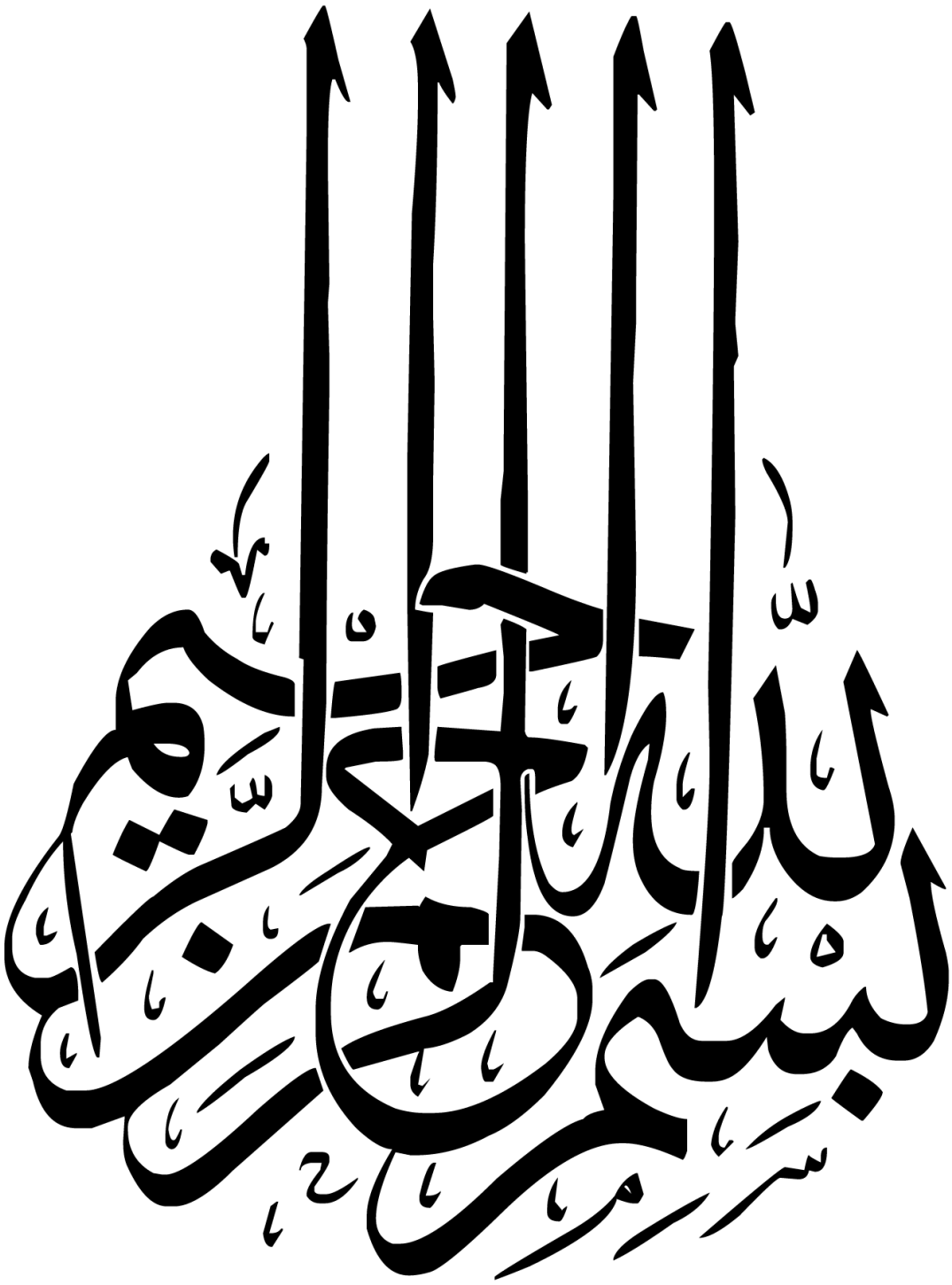
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Dedication

With deep gratitude and heartfelt emotion, I dedicate this work to those who have been my greatest source of strength and inspiration.

To my beloved parents, whose love, sacrifices, and unwavering support have shaped who I am today. Your patience and encouragement have carried me through every challenge, and this achievement is a reflection of everything you have given me.

To my dear little sister, the light of my life, whose smile brings me comfort and joy, and to my three brothers, for your constant support, strength, and the beautiful bond that unites us.

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To my dear friends, who have shared with me both the difficult and the joyful moments, thank you for your loyalty, encouragement, and for always believing in me.

This work is not only mine, but a piece of each of

DR. Nafti Rania

Dedication

First and foremost, I thank God for His mercy and guidance, which carried me through the hardest days of this journey and gave me strength when mine was not enough.

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Dr.Beroman Nihal Mariane

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Abreviation	Signification
A1AT	Alpha-1 Antitrypsin
ABG	Arterial Blood Gas
ACE	Angiotensin-Converting Enzyme
ACC	American College of Cardiology
ADA	American Diabetes Association
AHA	American Heart Association
ARB	Angiotensin II Receptor Blocker
BCAAs	Branched-Chain Amino Acids
BMI	Body Mass Index
BNP	B-type Natriuretic Peptide
BP	Blood Pressure
CD8+	CD8 positive T-lymphocytes
CHD	Coronary Heart Disease
COPD	Chronic Obstructive Pulmonary Disease
CRP	C-reactive Protein
CT	Computed Tomography
CXR	Chest X-ray
CVD	Cardiovascular Disease
DBP	Diastolic Blood Pressure
DLCO	Diffusing Capacity of the Lung for Carbon Monoxide
EGIR	European Group for the Study of Insulin Resistance
ESC	European Society of Cardiology
FEV_1	Forced Expiratory Volume in 1 second
FEV_1/FVC	Ratio of FEV_1 to FVC
FVC	Forced Vital Capacity
GLP-1	Glucagon-Like Peptide-1
GLP-1 RA	GLP-1 Receptor Agonists
GOLD	Global Initiative for Chronic Obstructive Lung Disease
HDL	High-Density Lipoprotein

Abreviation Signification

HIIT	High-Intensity Interval Training
HRCT	High-Resolution Computed Tomography
hs-CRP	High-sensitivity C-reactive Protein
IAS	International Atherosclerosis Society
IASO	International Association for the Study of Obesity
IDF	International Diabetes Federation
IFG	Impaired Fasting Glucose
IMC	Indice de Masse Corporelle
IGT	Impaired Glucose Tolerance
IL-6	Interleukin-6
IL-8	Interleukin-8
IR	Insulin Resistance
IASO	International Association for the Study of Obesity
JIS	Joint Interim Statement
LDL	Low-Density Lipoprotein
LPS	Lipopolysaccharides
LTOT	Long-Term Oxygen Therapy
MUC5AC	Mucin 5AC
NAFLD	Non-Alcoholic Fatty Liver Disease
NCEP-ATP III	National Cholesterol Education Program – Adult Treatment Panel III
NF-κB	Nuclear Factor kappa B
NHLBI	National Heart, Lung, and Blood Institute
NIV	Non-Invasive Ventilation
NO	Nitric Oxide
O_2^-	Superoxide anion
ORC	Obesity-Related Cancers
$PaCO_2$	Partial pressure of carbon dioxide
PaO_2	Partial pressure of oxygen

Abreviation	Signification
□PCOS	Polycystic Ovary Syndrome
□PEF	Peak Expiratory Flow
□PFTs	Pulmonary Function Tests
□RAAS	Renin-Angiotensin-Aldosterone System
□ROS	Reactive Oxygen Species
□SBP	Systolic Blood Pressure
□sdLDL	Small Dense Low-Density Lipoprotein
□SGLT-2	Sodium-Glucose Cotransporter-2
□SGLT-2i	SGLT-2 Inhibitors
□T2D	Type 2 Diabetes
□TG	Triglycerides
□TNF-α	Tumor Necrosis Factor alpha
□VLDL	Very Low-Density Lipoprotein
□VEGF	Vascular Endothelial Growth Factor
□WC	Waist Circumference
□WHF	World Heart Federation
WHO	World Health Organization
WHR	Waist-to-Hip Ratio

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Figure 14 : Association between metabolic syndrome and clinical, functional, and prognostic parameters in COPD patients.

Theoretical Framework

Introduction:

Chronic Obstructive Pulmonary Disease (COPD) constitutes a major global public health burden and remains one of the leading causes of morbidity and mortality worldwide. It is characterized by persistent airflow limitation and an exaggerated inflammatory response of the lungs to harmful particles and gases , particularly tobacco smoke .Traditionally considered a disease confined to the respiratory system, COPD is now widely recognized as a complex multisystem disorder with significant systemic consequences.

The pathophysiology of COPD involves chronic inflammation of the airways, lung parenchyma, and pulmonary vasculature . This persistent inflammatory process leads to structural alterations such as narrowing of small airways and destruction of alveolar walls , resulting in emphysema. These changes ultimately impair gas exchange , reduce lung elasticity , and limit expiratory airflow. Over time, these pathological processes contribute to progressive respiratory symptoms including chronic cough, sputum production , and dyspnea.

Beyond it pulmonary manifestation, COPD is increasingly associated with systemic inflammation that extends beyond the lungs. Circulating inflammatory mediators , such as cytokines and acute -phase proteins, play a crucial role in the development of extrapulmonary effects. These systemic features significantly contribute to disease severity, reduce quality of life , increased hospitalization rates , and mortality.

Among the various comorbidities linked to COPD, metabolic syndrome (MetS) has gained considerable attention in recent years .Metabolic syndrome refers to a cluster of interrelated metabolic abnormalities , including central obesity , insulin resistance , hypertension , and dyslipidemia . These factors collectively increase the risk of cardiovascular diseases and type 2 diabetes mellitus, further complicating the clinical course of COPD patients.

The coexistence of COPD and metabolic syndrome is not merely coincidental but it believed to share common underlying mechanisms , particularly chronic systemic inflammation and oxidative stress . Inflammatory pathways activated in COPD may contribute to insulin resistance and metabolic dysregulation, while metabolic abnormalities may , in turn ,exacerbate pulmonary inflammation and disease progression.

Epidemiological studies have demonstrated a higher prevalence of metabolic syndrome among patients with COPD compared ton the general population. This association varies depending on factors such as age, gender disease severity, lifestyle habits, and geographic region . The presence of metabolic syndrome in COPD patients is associated with worse clinical outcomes, including increased frequency of exacerbations, reduce exercise capacity , and higher cardiovascular risk.

Despite the growing recognition of Chronic Obstructive Pulmonary Disease (COPD) as a systemic condition, the burden of metabolic syndrome within this population remains insufficiently characterized.

Available literature reports a variable prevalence of metabolic syndrome among COPD patients, reflecting heterogeneity in study populations, diagnostic criteria, and disease stages.

Moreover, the relationship between metabolic syndrome and COPD severity remains complex and not fully elucidated. Metabolic abnormalities may potentially contribute to a more advanced disease profile, with greater functional impairment and increased clinical instability.

In addition, COPD is frequently accompanied by multiple comorbid conditions, particularly cardiovascular disease, diabetes mellitus, and dyslipidemia, which may coexist with or be influenced by metabolic syndrome, thereby worsening overall patient outcomes and increasing healthcare burden.

Taken together, these elements highlight the need for a better understanding of the coexistence of metabolic syndrome and COPD, its frequency, and its clinical implications..

PART I: COPD

I-1. Definition:

Chronic Obstructive pulmonary Disease (COPD) is defined by the Global Initiative for Chronic Obstructive Lung Disease(GOLD), COPD is defined as a common, preventable ,and treatable disease characterized by persistent respiratory symptoms and airflow limitation(Noureddine, n.d. ,2019) .

According to the American Thoracic society (ATS) and the European Respiratory Society (ERS) ,COPD is an inflammatory disorder marked by airflow obstruction that is typically progressive and not fully reversible , and may associated with significant systemic and extra pulmonary manifestation(Viegi et al., 2007).

Historically, COPD encompasses two distinct clinic-pathological entities:

1-chronic bronchitis defined clinically: by a productive cough for at least three months over two consecutive years

2-emphysema defined anatomically: by the permanent destruction of airspaces distal to the terminal bronchioles without evident fibrosis(Molfino & Jeffery, 2007) However, these entities are only classified as (« Broncho pneumopathie chronique obstructive (BPCO)—Troubles pulmonaires », n.d.) COPD when a persistent obstructive ventilator defect is confirmed ,specifically a post-bronchodilator FEV1/FVC ratio<0.70 or below the lower limit of Normal (LLN) .While asthma is generally distinguished by its unique pathogenesis , the ashtma - COPD Overlap (ACO) identifies cases where the two conditions coexist ,complicating the differential diagnosis which must also exclude congestive heart failure ,bronchiectasis ,and tuberculosis .In its advanced stages , the disease is characterized by chronic respiratory failure (CRF),severe systemic inflammation ,and metabolic disturbances , marking the progression toward end stage COPD

I-2. Etiopathogenesis and Pathophysiology

I-2-1 Pathology:

The histopathological pattern of Chronic Obstructive Pulmonary Disease (COPD) is characterized by severe structural remodeling and chronic inflammatory cellular changes in

three main anatomical locations. In the proximal and peripheral airways, cigarette smoke components cause epithelial disruption due to mucociliary apparatus and intercellular junctional complex damage. This enhances permeability, allowing deeper penetration of irritants and antigens, leading to a cascade of airway fibrosis and muscular hypertrophy. These alterations cause substantial reduction in the bronchial and bronchiolar luminal diameter, especially in the small airways with diameters less than 2 mm,(Molfino & Jeffery, 2007) which is the main site of airflow obstruction.Concurrently, the pulmonary parenchyma shows severe deterioration, mainly due to emphysema. This destructive process is often aggravated by alpha1-antitrypsin deficiency and impaired tissue repair mechanisms, as indicated by reduced Vascular Endothelial Growth Factor (VEGF) and its receptors, which play a pivotal role in the survival and maintenance of endothelial cells. Moreover, the pulmonary vasculature shows intense intimal thickening due to smooth muscle cell proliferation and collagen and elastic fiber deposition. This inflammatory reaction in the pulmonary arteries worsens as the disease advances, adding to the systemic complexity of the disease.

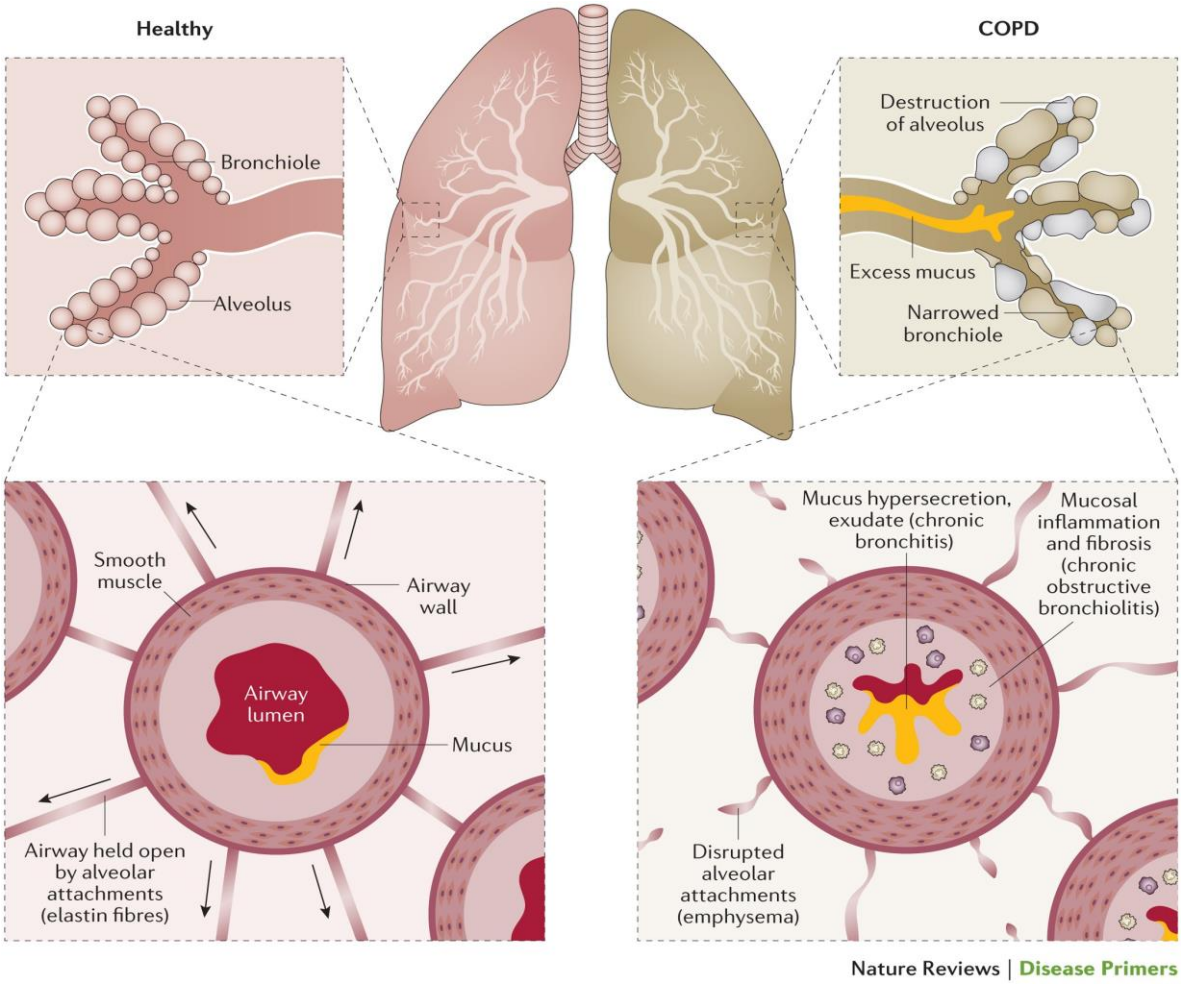


Figure 01 : The histopathological of Chronic Obsturctive pulmonary disease

From : https://www.nature.com/articles/nrdp201576

I-2-2 Pathophysiology:

The pathophysiology of Chronic Obstructive Pulmonary Disease (COPD) is a complex, multi-component process in which there is an airflow limitation that is not fully reversible. This involves a combination of mucociliary dysfunction, as characterized by increased size of the goblet cells and submucosal gland hypertrophy with mucus hypersecretion, and chronic airway inflammation characterized by the recruitment of neutrophils, macrophages, and CD8+ T-lymphocytes. These cells secrete powerful mediators such as Interleukin-8 (IL-8), Leukotriene B4 (LTB4), and Tumor Necrosis Factor-alpha (TNF-alpha), which play a crucial role in tissue damage. The tissue damage in COPD involves structural changes such as the destruction of lung tissue, referred to as emphysema. The destruction of the lung tissue leads to the loss of

elasticity, referred to as "parenchymal tethering." The loss of elasticity leads to the collapse of small airways during expiration, causing the hyperinflation of the lungs. In addition to the pulmonary changes, COPD presents as a systemic inflammatory disease in which there are increased levels of factors such as C-reactive protein (CRP), fibrinogen in the blood, and TNF alpha. These factors play a crucial role in the extrapulmonary manifestations of COPD, such as : cachexia, cardiovascular disease, and skeletal muscle wasting (« Bronchopneumopathie chronique obstructive (BPCO)—Troubles pulmonaires », n.d.) .Moreover, an imbalance of oxidative stres whereby free radicals such as the superoxide anion (O2) and hydrogen peroxide (H2O) overwhelm the body's antioxidant defense mechanisms, activates transcription factors such as Nuclear Factor-kappa B (NF-kappab), which in turn, overregulates the expression of mucin gene expression, such as MUC5AC, and proteases, ensuring the persistence of the disease even after the removal of the original insult (Rodríguez-Roisin, 2005)

I-3. Diagnosis:

I-3-1. Symptoms:

Chronic Obstructive Pulmonary Disease (COPD) shows significant clinical heterogeneity, where the patient may present with various symptoms that increase with the progression of the disease. The major diagnostic criteria include the history of exposure to etiologic factors and the presence of significant respiratory symptoms. According to the NICE guidelines of 2018, the diagnosis of COPD is considered in smokers or former smokers aged over 35 years with one or more associated symptoms of chronic cough, sputum production, exceptional breathlessness, or wheezing [NICE, 2018](Rodríguez-Roisin, 2005) The initial manifestation of the disease may be a cough, which gradually progresses from intermittent to a regular day-to-day occurrence , . Moreover the definition of the GOLD (2020) highlights that the host factors, which include lung development, coexisting conditions, and lung physiology, significantly affect the pathogenesis of the disease.

COPD currently includes chronic bronchitis and emphysema, which may be centrilobular and/or panlobular , associated with airflow obstruction (AO .The definition of chronic bronchitis is purely clinical : it is a disease of the bronchial tree, associated with mucous

hypersecretion and a productive cough on a daily basis for at least three months of the year, for two consecutive years ,without any other identified cause(Hagstad, 2015)

Chronic bronchitis may exist as a simple bronchial condition or within an obstructive environment this association with persistent airway obstruction is what defines it as part of COPD

I-3-2. Clinical Examination:

The clinical assessment of the patient with COPD starts with a general assessment to note the patient's capacity to speak in full sentences. This is because fragmented speech is a red flag for the patient's respiratory distress. The assessment of the patient with COPD continues with the identification of pulmonary cachexia through a low BMI. This is associated with the emphysematous 'pink puffer' phenotype. There is a high mortality rate among these patients. The tripod position and pursed-lip breathing indicate the patient's subconscious attempt to fix the shoulder girdle to prevent the collapse of the airway. The presence of central cyanosis in the oral mucosa or a flapping tremor (asterixis) indicates critical physiological failure through severe hypoxemia or hypercapnia (CO2 retention). The assessment of the patient with COPD continues with the observation of the barrel chest deformity. This indicates a permanent increase in the antero-posterior diameter.

Palpation of accessory muscle hypertrophy in the neck and a decrease in cricosternal distance (less than 3 finger breadths) is physical evidence of a hyperinflated state. An important diagnostic feature is Hoover’s Sign(Alrabbaie et al., 2025)

where paradoxical inward motion of the lower rib cage occurs during inspiration, thus proving that the diaphragm is flattened and in a disadvantageous position.

Percussion reveals diffuse hyperresonance and a lack of dullness over the heart area, as the hyperinflated lungs cover the heart and liver.

Upon auscultation, a decrease in breath sounds, termed a "silent chest," is a hallmark of this disease, along with a pathologically prolonged expiratory phase, exceeding a normal 1:2 ratio. The auscultation also includes listening for expiratory wheezing, indicative of flow limitation in narrowed airways, and crackles during early inspiration, distinguishing COPD from pulmonary fibrosis, in which crackles are heard later in inspiration. Outside of auscultation, a determination of pitting edema in the periphery must be made, indicative of Cor pulmonale, a right-sided heart failure secondary to chronic pulmonary hypertension. Finally, using these

signs in conjunction with the 2026 GOLD Guidelines allows a "treatable traits" approach to be employed, moving beyond a diagnosis and into a more holistic approach to treating this disease, far more indicative of a patient's state than a static imaging approach.

I-4. Pulmonary Function Tests (PFTs):

The diagnosis of COPD requires a combination of clinical assessment and objective measurement of lung function symptoms such as chronic cough ,sputum production , and dyspnea may raise suspicion of the disease .however these symptoms alone are not sufficient for a definitive diagnosis .Therefore ,pulmonary function testing plays a crucial role in confirming the presence of airflow obstruction and determining disease severity Pulmonary Function Tests (PFTs) are a group of non -invasive procedures that evaluate lung function .These tests measure lung volumes , airflow rates , and gas exchange capacity . They provide valuable information about the mechanical function of the lungs and help physicians identify abnormalities in respiratory physiology .In patients suspected of having COPD, pulmonary function testing is essential to confirm airflow limitation and assess its severity(Celli et al., 2004)

Among the different pulmonary function tests available , spirometry is considered the most important and widely used method for diagnosing COPD. Spirometry measures the volume of air inhaled and exhaled by the lungs(Wanger et al., 2005) and the speed of airflow during breathing .It is a simple, reliable ,and relatively inexpensive test that can be performed in most healthcare settings.

During the spirometry test , the patient is asked to take a deep breath and then exhale as forcefully and completely as possible into a spirometer .This maneuver allows the measurements obtained from spirometry(Pellegrino et al., 2005) are the Forced Expiratory Volume in 1 second (FEV_1) and the Forced Vital Capacity (FVC).

FEV_1 represents the volume of air that a person can forcefully exhale during the first second of expiration after a full inspiration .This value reflects the degree of airway obstruction and is significantly reduced in patients with COPD . FVC, on the other hand, represents the total volume of air that can be exhaled forcefully after a maximal inhalation(Vestbo et al., 2013)

The ratio between FEV_1 and FVC , known as the FEV1/FVC ratio , is the key parameter used to detect airflow obstruction .In healthy individuals , this ratio is usually above 0.70.

However , in patients with COPD ,the ratio is reduced because airway narrowing limits the amount of air that can be exhaled rapidly(Quanjer et al., 2012).

The configuration of the flow volume loop is of primary importance in respiratory assessment. In addition to providing information, the loop is the first indicator of a successful test, its validity, and its quality. An experienced practitioner will immediately recognize if a maneuver was performed with maximum effort and consistency, simply by observing the smoothness of the curve.

In Obstructive Syndrome, in cases of Obstructive Ventilatory Defects (OVD), as in COPD, certain characteristic changes are observed in the morphology of the curve:

Expiratory Limb Concavity: The most characteristic feature of Obstructive Syndrome is the "scooped out" or concave configuration of the curve in the descending part of the expiratory limb

Correlation with Disease Severity: The concavity of the curve is directly proportional to the severity of the Obstructive Syndrome

In more severe cases, the concavity of the curve is more marked, with a consequent decrease in Peak Expiratory Flow (PEF).

Region of the expiratory curve can frequently be the initial clinical of small airway disease, heven thoug the FEV_1_measurement may be well within the relatively normal range.

In addition to spirometry , other pulmonary function tests can provide further information about lung physiology in patients with COPD .For example , measurement of lung volumes can detect hyperinflation and air trapping , which are common features of advanced COPD.

Another important pulmonary function test is the measurement of the diffusing capacity of the lungs for carbon monoxide (DLCO) . This test evaluates the ability of gases to transfer from the alveoli into the bloodstream .In patients with emphysema , a form of COPD characterized by destruction of alveolar walls, the DLCO is often significantly reduced.

Pulmonary function tests are also useful for distinguishing COPD from other respiratory conditions such as asthma , airflow obstruction is usually reversible after bronchodilator therapy , while COPD the obstruction remains persistent.

Furthermore , pulmonary function testing plays a critical role in monitoring disease progression and evaluating treatment effectiveness . Regular assessment of lung function allows clinicians to adjust therapy and improve patient outcomes.

I-5. Additional Investigations:

Chest X-rays : while chest radiography (CXR) lacks the sensitivity to diagnose Chronic Obstructive Pulmonary Disease (COPD) in early stages ,it remains a fundamental component of the initial diagnostic workup .Its primary clinical utility lies in the exclusion of differential diagnoses and identification of significant comorbidities , such as lung cancer, bronchiectasis , or congestive heart failure .In advanced cases ,CXR can reveal characteristic signs of pulmonary hyperinflation , including the flattening of the hemi-diaphragms , increased retrosternal airspace , and horizontalization of the ribs .Furthermore , it allows for the detection of bullous emphysema (Wallace et al., 2009)and signs of pulmonary hypertension in chronic stages. However , because a normal radiograph does not rule out airflow limitation ,it must always be interpreted alongside spirometry ,which remains the gold standard for confirming persistent airway obstruction

Computed Tomography (CT): has emerged as a cornerstone for the structural evaluation and phenotyping of Chronic Obstructive Pulmonary Disease (COPD) .While not mandatory for a baseline diagnosis , high-resolution CT (HRCT) is superior to chest radiography in characterizing the extent and distribution of emphysema ,whether centrilobular or panacinar .It serves as a critical diagnostic tool for patients whose clinical symptoms , such as severe dyspnea , are disproportionate to their spirometric results

.Furthermore, CT imaging is indispensable for identifying “overlap” syndromes, such as coexisting bronchiectasis or interstitial lung disease , and for guiding advanced interventions like lung volume reduction.by detecting early structural changes in management of the disease’s various clinical phenotypes

In cases of severe COPD, an **echocardiogram** could reveal pulmonary hypertension or other cardiac comorbidities.

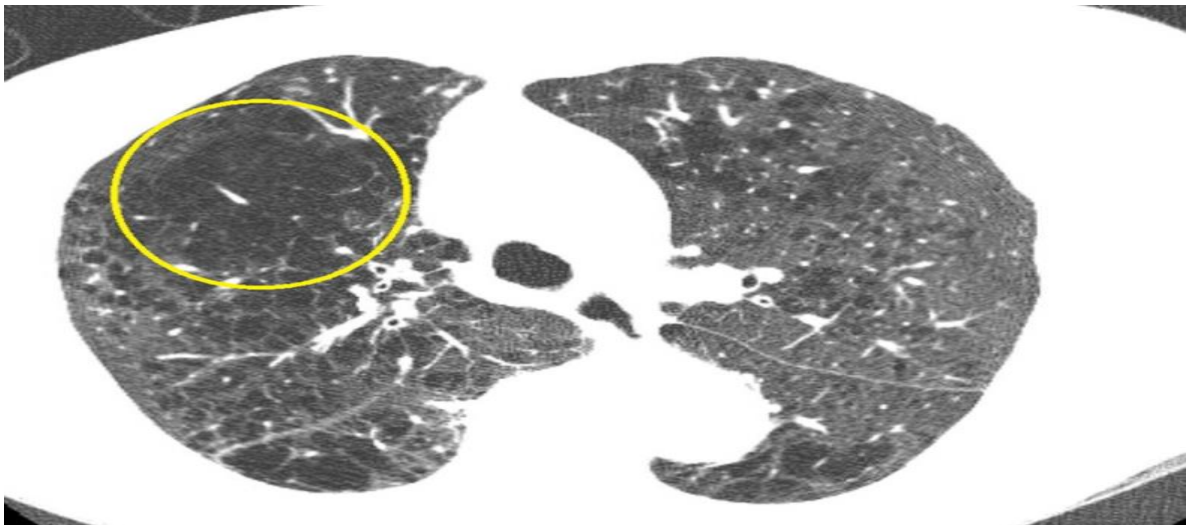


Figure 02 : Emphysema in Computed Tomography**.**

From : https://www.diagnosticimaging.com/view/emphysema-chest-ct-threefold-higher-risk-copd-mortality-next-25-years

Arterial blood gas (ABG): is a critical diagnostic tool for assessing the severity and complications of (COPD)

. While spirometry defines the degree of airflow obstruction, ABG remains the gold standard for identifying respiratory failure (Ak, Ogun, Bayir, Kayis, & Koylu, 2006) by measuring the partial pressures of oxygen (PaO2) and carbon dioxide (PaCO2).

It is specifically indicated for patients with VEMS <50% predicted , or those presenting clinical signs of hypoxemia or right heart failure .Furthermore ,ABG is essential for diagnosis hypercapnia and respiratory acidosis during acute exacerbations ,guiding the need for non-invasive ventilation (NIV) .By evaluating the acid-base-balance , this test provides definitive data for prescribing long-term oxygen therapy (LTOT) , which is proven to improve survival in patients with chronic severe hypoxemia.

I-6. Comorbidities:

There is a consensus across clinical studies that the global morbidity and mortality burden of Chronic Obstructive Pulmonary Disease (COPD) is escalating. Recent advancements in understanding COPD's pathophysiology, particularly the role of systemic inflammation, have elucidated the high prevalence of significant comorbidities—such as cardiovascular, skeletal,

and nutritional impairments. These conditions occur alongside age-related ailments and disorders stemming from shared risk factors.

I-6-1 Cadio-vascular disease :

is the most frequent and serious comorbidity associated with COPD, primarily due to the shared risk factor of smoking and the biological mechanism of systemic spillover .Chronic pulmonary inflammation leads to the release of pro-inflammatory cytokines such as IL-6 and TNF-a into the bloodstream .This systemic state triggers the liver to produce (CRP) , which promotes vascular endothelial dysfunction and accelerates arterial stiffness .Consequently, COPD patients face a significantly elevated risk of ischemic heart disease,heart failure , and arrhythmias, often regardless of their smoking history

I-6-2. Skeletal Muscle Dysfunction and Osteoporosis:

(COPD) significantly impacts the musculoskeletal system through a combination of systemic inflammation, chronic hypoxia, and physical inactivity .The “systemic inflammation” activates proteolytic pathways , leading to an imbalance where protein degradation exceeds synthesis, resulting in sarcopenia(muscle wasting) and reduced exercise tolerance. Simultaneously, high levels of circulating TNF-a stimulate osteoclast activity , which compounded by the frequent use of systemic corticosteroids and vitamin D deficiency , leads to a rapid decline in bone mineral density .This progression often culminates in osteoporosis , placing patients at a high risk for debilitating vertebral and hip fractures.

I-6-3. Metabolic and Nutritional Disorders:

Metabolic dysfunction is hallmark of advanced COPD , often manifesting as Type2 Diabetes or metabolic syndrome .The persistent inflammatory state interferes with insulin signaling pathways , creating a state of insulin resistance that is further exacerbated by the sedentary lifestyle necessitated by chronic dyspnea .On the opposite end of the nutritional spectrum, some patients develop pulmonary cachexia ,a severe loss of fat-free mass .This low Body Mass Index(BMI) is a critical independent predictor of mortality, as it reflects a state of chronic energy imbalance and high metabolic demand caused by the increased work of breathing.

I-6-4 Mental Health : Anxiety and depression

The psychological burden of COPD is profound, with anxiety depression affecting a large percentage of the patient population.. Pathophysiologically ,this is linked to the distressing nature of chronic breathlessness and the social isolation resulting from physical limitations.

Furthermore, emerging research suggests a biological link where chronic hypoxia and systemic inflammation may alter neurotransmitter function or cross the blood-brain barrier, directly contributing to clinical depression .These mental health comorbidities are critical as they often lead to poor treatment adherence and higher frequency of acute exacerbation

I-7. Differential Diagnosis:

The clinical identification of Chronic Obstructive Pulmonary Disease (COPD) necessitates a meticulous differential diagnosis, as its primary symptoms progressive dyspnea and chronic sputum production are shared by several respiratory and cardiac pathologies. The most frequent diagnostic challenge is distinguishing COPD from **Bronchial Asthma** , particularly in older patients with a history of smoking .While both involve airway obstruction , asthma is typically characterized by an earlier age of onset , significant symptom variability , and a largely reversible airflow limitation following a bronchodilator test .In contrast , COPD presents with a persistent , non-reversible FEV_1/FVC ratio of less than 0.70. Furthermore, clinicians must evaluate for **Congestive Heart Failure (CHF)**, which often mimics COPD-related breathlessness .Distinctive features of CHF include the presence of fine basilar crackles upon auscultation , cardiomegaly or pulmonary edema on a chest X- ray , and restricted lung volumes rather than the hyperinflation typically seen in emphysematous COPD. Elevated levels of B -type natriuretic peptide (BNP) further support a cardiac etiology over a primary pulmonary one.

Beyond cardiac concerns , Bronchiectasis must be considered when a patient presents with massive volumes of purulent sputum and recurrent respiratory infection .This condition is definitively identified via High-Resolution Computed Tomography (HRCT), which reveals characteristic bronchial dilation and “ signetring” signs, as opposed to the parenchymal destruction seen in COPD .Additionally, chronic infection such as **Tuberculosis** remain a critical differential in specific geographic regions, often maked by systemic symptoms like nigh sweats , hemoptysis , and apical opacities on imaging .Finally rarer conditions like

Obliterative Bronchiolitis or **Diffuse panbronchiolitis** may be considered when the clinical presentation does not align with typical tobacco-smoke exposure .Establishing these distinctions is vital for therapeutic accuracy , as the reliance on long-acting bronchodilators in COPD differs fundamentally from the corticosteroid centric approach in asthma or the diuretic requirements of heart failure

Table 01: Technical Comparison:

Diagnostic Entity	Distinguishing Clinical Features	Definitive Test/Finding
Asthma	Nocturnal symptoms, history of atopy	Significant FEV_1 increase >12% post-BD
Heart Failure	Orthopnea , peripheral edema	Cardiomegaly on X-ray, Elevated BNP
Bronchiectasis	Copious purulent sputum	Bronchial wall Thickening/dilation on HRCT
Tuberculosis	Fever, weight loss, apical infiltrates	Positive sputum culture /PCR for M .tuberculosis

I-8. Managemnet and Treatment Of COPD :

Management of COPD focuses on relieving symptoms , improving quality of life, and reducing exacerbations through a combination of pharmacological and non-pharmacological strategies .Smoking cessation remains the most important intervention to slow disease progression . Pharmacological treatment is based mainly on bronchodilators , including long-acting beta-agonists and muscarinic antagonists , with inhaled corticosteroids added in patients who experience frequent exacerbations .In more advanced stages , drugs such as Roflumilast can be used to decrease inflammation and exacerbation frequency. Non-pharmacological measures such as pulmonary rehabilitation, vaccination, nutritional support ,

and long-term oxygen therapy play a key role in improving functional capacity and survival . In patients with coexisting metabolic syndrome , management becomes more complex and requires addressing both respiratory and metabolic abnormalities . Lifestyle modifications, including increased physical activity , weight reduction , and a balanced diet, are essential to control metabolic risk factors and improve overall outcomes. Proper management of hypertension , diabetes , and dyslipidemia is also necessary to reduce cardiovascular risk . Special attention should be given to the use of systemic corticosteroids, as prolonged use may worsen metabolic disturbances . An integrated and multidisciplinary approach is therefore crucial, involving coordination between respiratory, cardiovascular , and endocrine care to optimize treatment and reduce complications

Part II : Metabolic syndrome

II-1. Definition and conceptual evolution :

The metabolic syndrome (MetS) is not a single disease but it represents a cluster of interrelated bilogical and clinical conditions, such as abdominal obisity, impared glucose metabolisme, dyslipidemia and high blood pressure, which tend to occur together and share common pathophysiological mechanisms, specially insulin resistance and chronic low-grade inflammation (Huang, 2009).Rather than representing a single disease entity,metabolic syndrome reflects a multifactorial condition that significantly increases the risk of cardiovascular diseases en type 2 diabetes mellitus (Opie, 2007).

Over recents decades,metabolic syndrome has become a major golobal public health problem due to its high prevalence and its strong association with severe complications such as coronary artery disease,stroke,chronic kidney disease,and increased all-cause mortality(Alberti et al., 2009). The heterogeneity of its clinical manifestations and the different diagnostic criteria have led several international organizations to prospose standradized definitions in order to improve comparability between populations (Alberti et al., 2009).

II-1-1. History and Evolution of Diagnostic Criteria :

The clinical recognition of metabolic syndrome has transitioned from a mere observation of co-occurring symptoms to a strictly defined global health priority. This evolution reflects the medical community's effort to standardize diagnosis across different populations.

II -1-2. The Early Origins and "Syndrome X" :

While the association between hypertension ,hyperglycemia, end gout was noted as early as 1923 by kylin, and android obesity was identified by Jean Vague in 1947, the modern era began in 1988,Gerald Reaven introduced the landmark concept of Syndrome X.He was the first formalize the hypothesis that insuline resistance was the common denominator linking glucose intolerance ,hypertension, and dyslipidemia .At this stage obesity was surprisingly not included in Reaven's original criteria, as the focus was strictly on the metabolic action of insulin **(Alberti et al., 2009)**.

II-1-3. The Proliferation of definitions (WHO,EGIR,AND NCEP

As the clinical importance of the syndrome grew, different organizations proposed their own criteria, leading to a period of diagnostic confusion :

WHO (1998 - 1999) & EGIR (1999): These definitions maintained the "Reaven" tradition by requiring documented insulin resistance (or impaired glucose tolerance) as a mandatory component for diagnosis(Huang, 2009).

NCEP-ATP III (2001): Seeking a more practical tool for clinical practice, the definition of th National Cholesterol Education Program did not require a mandatory factor. A patient simply needed any 3 out of 5 risk factors. This made the syndrome much easier to diagnose in a standard office setting(Day, 2007).

The International Diabetes Federation (IDF) and Populatio Variability

In 2005, the IDF sought the creat a "Worldwide Definition" based on two major shifts : Mandatory central obesity : Unlike the NCEP, IDF made a high waist circumference a prerequisite for diagnosis.Ethnic-Specific Thresholds: For the first time, it was officially recognized that the definition must vary according to the population. For example, the waist circumference cut-off for men was set at ≥ 94 cm for Europids but : ≥ 90 cm for South Asians. This was a crucial step in acknowledging that different ethnic groups develop metabolic complications at different levels of adiposity(Zimmet, Alberti, & Serrano Ríos, 2005).

II -1-4. The Need for International Harmonization (2009)

The existence of two competing major definitions (NCEP-ATP III and IDF) has made a lack of diagnostic concordance, a patient could be classified as having MetS under one definition but not the other.To resolve this, a Joint Interim Statement was released in 2009 to "harmonize" the criteria. This modern consensus removed the mandatory status of any single criteria (reverting to the "3 out of 5" rule)and retained the ethnic-specific waist circumference measurements, making it both scientifically flexible and globally applicable (Alberti et al., 2009).

II-2. Diagnostic Criteria According to International Organizations

The diagnostic framework for metabolic syndrome (MetS) has undergone significant refinement over the last three decades.

II-2-1. World Health Organization (WHO, 1998-99)

The WHO was the first to formalize the syndrome, focusing heavily on the pathophysiological role of insulin.

Mandatory Criterion: The presence of Insulin Resistance, defined as Type 2 diabetes, impaired fasting glucose (IFG), or impaired glucose tolerance (IGT).

Associated Criteria: At least two of the following:

-Body Mass Index (BMI): > 30 kg/m² and/or waist-to-hip ratio > 0.90 (men) or > 0.85 (women).

- Dyslipidemia: Triglycerides ≥1.50 g/L (1.7 mmol/L) or HDL-cholesterol < 0.35 g/L (men) or < 0.39 g/L (women).

- Blood Pressure: ≥ 140/90 mmHg.

-Microalbuminuria: Urinary albumin excretion rate ≥ 20 µg/min or albumin-to-creatinine ratio ≥ 30 mg/g (Junquero & Rival, 2005).

II -2-2. National Cholesterol Education Program (NCEP-ATP III, 2001)

The NCEP-ATP III moved away from mandatory insulin testing to create a practical tool for clinical use

Methodology: A "three-out-of-five" approach. Diagnosis is confirmed if three or more of the following are present:

1 -Abdominal Obesity: Waist circumference > 102 cm (men) or > 88 cm (women).

2 -Hypertriglyceridemia: ≥1.50 g/L.

3 -Low HDL-Cholesterol: < 0.40g/L (men) or < 0.50 g/L (women).

4 - Blood Pressure: ≥130/85 mmHg.

5 -Fasting Glucose: ≥1.10 g/L (later revised to ≥ 1.00 g/L) (Huang, 2009).

II -2-3. The European Group for The Study of Insulin Resistence (EGIR, 2002)

The European group proposed in 2002 a definition of metabolic syndrome sepicially for non diabetic patients,which deffers from the WHO and the NCEP-ATP III, and according to this definition a person is considered to have metabolic syndrome if they have :

Fasting hyerinsulinemia (above the upper quartile of a normal population) and at least two of the follozing abnormalities :

1- Waist circumference > 94 cm (men) and > 80 cm (women).

2- Fasting glucose > 110 mg/dL.

3-Systolic blood pressure > 140 mmHg and/or diastolic BP > 90 mmHg, or antihypertensive treatment.

4 - Triglycerides > 180 mg/dL and/or HDL cholesterol < 40 mg/dL, or lipid-lowering treatmen.(Giangregorio et al., 2024)

II-2-4. International Diabetes Federation (IDF, 2005)

The IDF emphasized that visceral adiposity is the primary trigger for the metabolic cascade.

Mandatory Criterion: Central Obesity, defined by waist circumference thresholds tailored to ethnicity.

Thresholds by Ethnicity:

Europids: ≥ 94 cm (men), ≥80 cm (women).

South Asians/Chinese: ≥ 90 cm (men), ≥ 80 cm (women).

Japanese: ≥90 cm (men), ≥80 cm (women).

Additional Criteria: Any two of the following: elevated triglycerides (≥ 1.50g/L), reduced HDL, elevated blood pressure (≥130/85 mmHg), or elevated fasting plasma glucose (≥1.00 g/L) (Alberti et al., 2009).

Table 02 : Definitions of metabolic syndrome :

WHO	IDF	NCEP	EGIR
Fasting insulin>57thpercentile, or fasting glucose≥6,1 mmol/l,or 2 h glucose≥7,8	waist≥94 cm in men or≥80 cm in women	-	Fasting insulin>75thpercentile
And	And	None but	And
At least any two of the following	At least any two of the following	At least any three of the following	At least any two of the following
1.waist/hip ratio>0.90cm in men or>0.85cm in women,or BMI ≥30kh/m^3	1.fasting glucose≥5.6mmol/L	1.waist ≥102 cm in men or88cm in women	1.Fasting glucose≥6.1mml/L
2.SBP/DBP≥140/90mmHg or medication	2.HDL<1.03mmol/l in men or <1.29 mmol/Lin women	2.HDL<1.03mmol/l in men or <1.29 mmol/Lin women	2.HDL<1.0mmol/L
3.HDL<0.90mmol/l in men or< 1.0 mmol/l in women	3.TG≥1.7mmol/L	3.TG≥1.7mmol/L	3.TG>2.0mmol/L
4. TG ≥1,7mmol/l	4.SBP/DBP≥130/85 or medication	4.SBP/DBP≥130/85 or medication	4. waist ≥94cm in men or80cm in women
5.Urinary albumin/urinary creatinine ratio≥3.39mg/mmol(30mg/g)	-	5.Fasting glucose ≥6.1mmol/L	5.SBP/DBP ≥140/90mmHg or medication

II-2-5. The Harmonized Definition (JIS, 2009)

To create a single global standard, several organizations (IDF, AHA, NHLBI, WHF, IAS, and IASO) released the Joint Interim Statement (JIS).

Core Principle: No single criterion is mandatory.

Diagnostic Rule: Presence of any three out of five 3/5 risk factors:

- Elevated Waist Circumference: Population-specific thresholds.

- Elevated Triglycerides: ≥150 mg/dL (1.7 mmol/L). or on treatment for elevated triglycerides

- Reduced HDL-C: < 40 mg/dL (men) or < 50 mg/dL (women). Or on treatment

- Elevated Blood Pressure: Systolic ≥ 130 and/or diastolic ≥ 85 mmHg. Or on antihypertensive treatment

- Elevated Fasting Glucose: ≥ 100 mg/dL (5.6 mmol/L). or previously diagnosed type 2 diabetes(Alberti et al., 2009)

II-3. PREVALENCE OF METABOLIC SYNDROME

The Metabolic syndrome (MetS) has emerged as a major public health challenge of this century. Its prevalence continues to rise sharply, driven by rapid urbanization, nutritional transition, and the widespread adoption of sedentary lifestyles. Although its frequency varies depending on the diagnostic criteria used (e.g., NCEP-ATP III or IDF), the overall global trend is consistently increasing, affecting all age groups and regions(Noubiap et al., 2025).

II-3-1. Global prevalence

The global distribution of metabolic syndrome shows notable geographic and sex-related disparities. Higher prevalence rates have been reported in countries such as Bermuda, Puerto Rico, Iraq, and the Czech Republic, whereas lower rates are observed in countries like Burundi, Chad, and Afghanistan.

Between 2000 and 2023, global prevalence went from**14.7% to 31.0%** among women, and from **9.0% to 25.7%** among men (Noubiap et al., 2025).

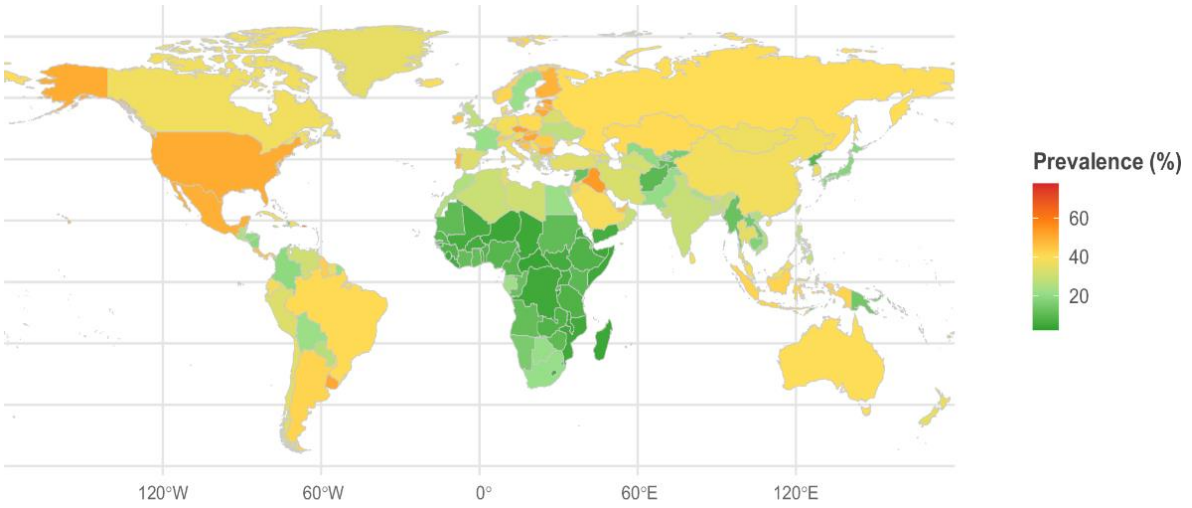


Figure 03 : Global map of metabolic syndrome prevalence in 2023 among women

From: Worldwide trends in metabolic syndrome from 2000 to 2023: a systematic review and modelling analysis

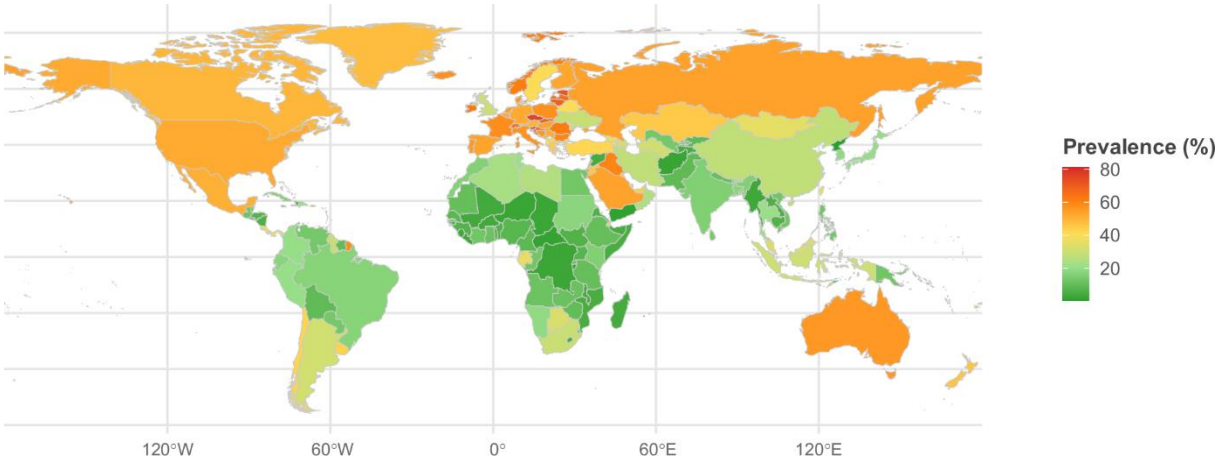


Figure 04 : Global map of metabolic syndrome prevalence in 2023 among men

From: Worldwide trends in metabolic syndrome from 2000 to 2023: a systematic review and modelling analysis

II-3-2. Impact of Urbanization:

Prevalence is significantly higher in urban areas (approximately **38%**) compared to rural areas (**12%**). This highlights the impact of modern lifestyles, characterized by the consumption of

ultra-processed foods and a decrease in physical activity(Noubiap et al., 2025; Peterseim, Jabbour, & Kamath Mulki, 2024).

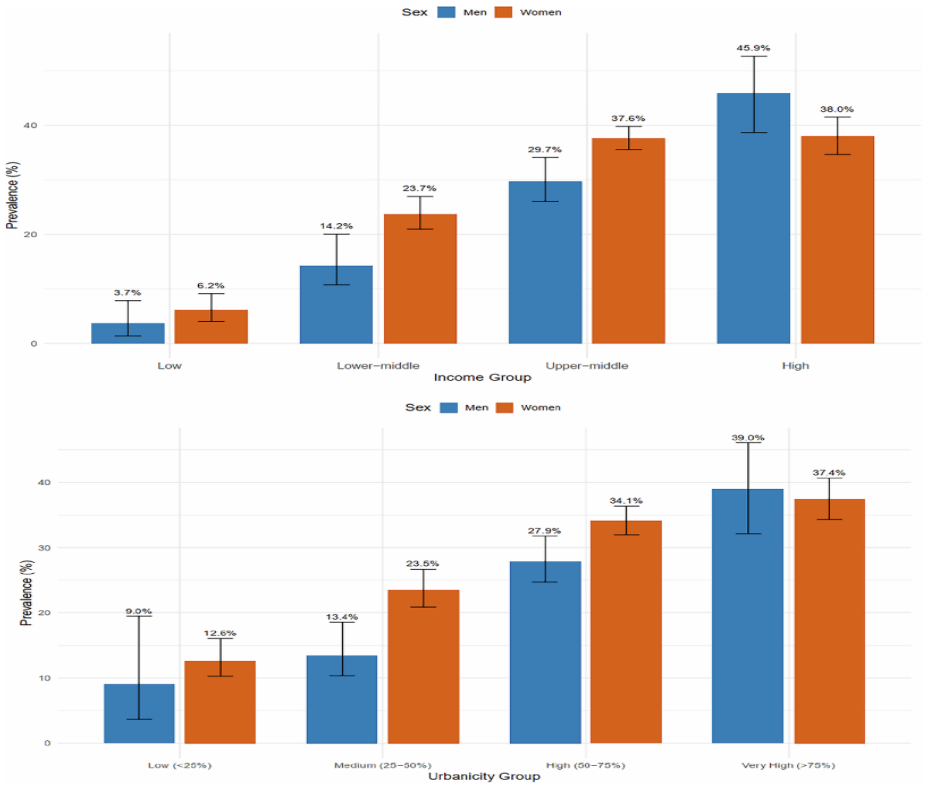


Figure 05 : Metabolic syndrome prevalence by sex across national income and urbanicity groups in 2023.

From: Worldwide trends in metabolic syndrome from 2000 to 2023: a systematic review and modelling analysis

II-3-3. Age Variations: The risk increases systematically with age, peaking between the ages of 65 and 74.

II-3-4. Regional Exemples : Middle East and High-Risk Zones

The Middle East and North Africa (MENA) region is characterized by a markedly high prevalence of metabolic syndrome, largely driven by rapid urbanization, lifestyle changes, and increasing obesity rates. In Saudi Arabia, prevalence estimates range between 30% and 40%, while Iran reports similarly elevated rates, particularly among women. Iraq also demonstrates a substantial burden, with notable sex-related disparities favoring higher prevalence in females (Noubiap et al., 2025)

Situation in Africa and the Maghreb

Sub-Saharan Africa remains the least affected region, with an estimated prevalence of approximately 10%, although rates are rising in some countries, particularly in Southern Africa, due to the progressive westernization of dietary habits(Noubiap et al., 2025).

In contrast, the Maghreb region shows significantly higher prevalence rates. In Tunisia and Morocco, local studies report prevalence ranging between 25% and 36%, as illustrated by the HSHS 2022 study conducted in Tunisia (Daouas et al., 2022).

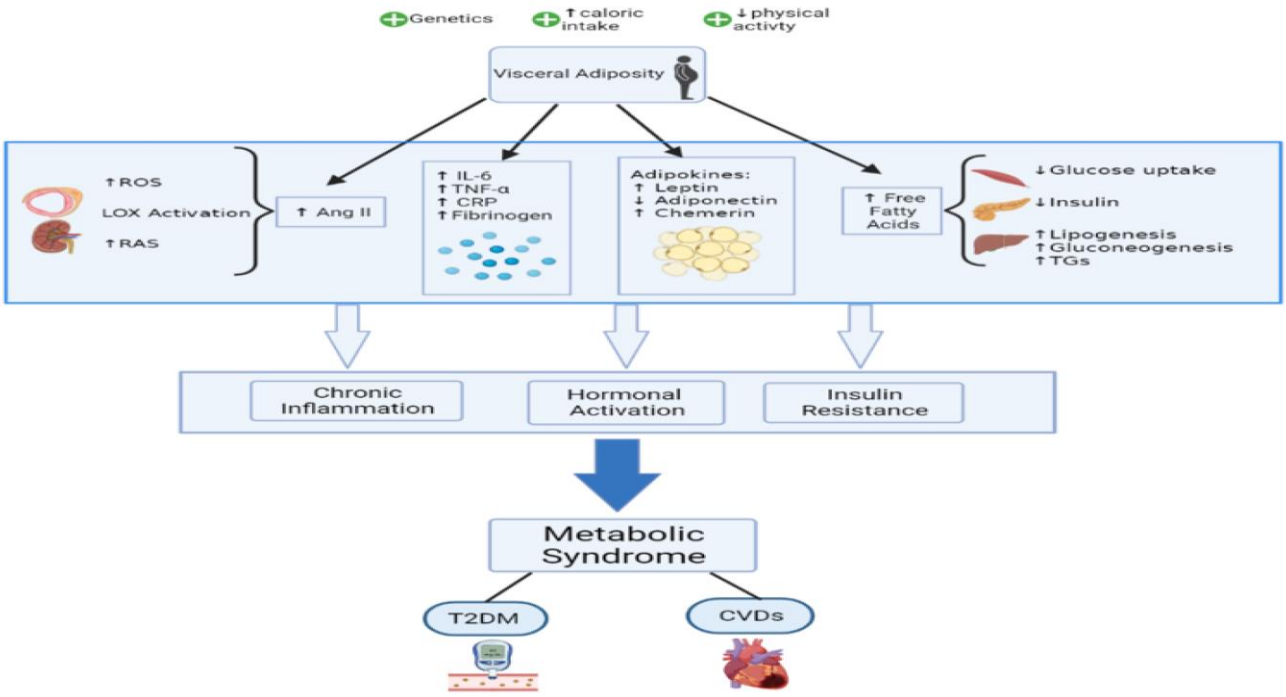
In Algeria, metabolic syndrome follows the upward trend observed across the MENA region, with a marked sex-related disparity. Approximately one in three adults is affected, with a prevalence of 39.1% among women and 29.1% among men (Ngwasiri et al., 2023).

At the local level, a study conducted in Oran in 2016 reported a prevalence of 25.9% among women compared to 13.7% among men (Houti et al., 2016).

Regarding Laghouat, it is important to highlight the heterogeneity in the availability of epidemiological data across Algeria. Currently, there is a lack of published data allowing an accurate assessment of the prevalence of metabolic syndrome in this region. This gap underscores the need for updated, large-scale local studies.

II-4. PATHOPHYSIOLOGY OF METABOLIC SYNDROME

The pathophysiology of Metabolic Syndrome(MetS) is characterized by a complex interaction between genetix predisposition and environmental factors, such as hypercaloric diets and sedentary lifestyle. While the exact trarting point is not so clear, current scientific consensus identifies visceral obesity and insulin resistance as the main primary drivers of this syndrome(Fahed et al., 2022).



Figur 06: Mechanisms highlighting MetS pathophysiology.

From : https://www.mdpi.com/1422-0067/23/2/786

II-4-1. Visceral Adiposity:

Modern research, emphazies that white adipose tissue, particulary in the visceral compartment, is an active endocrine and immune orgamn rather than a simple fat storage site.

-Adipocyte Dysfunction: Chronic positive energy balance leads to adipocyte hypertrophy. When these cells reach their storage limit, they undergo mechanical stress leading to local hypoxia.

-Adipokine Imbalance: Hypoxic and stressed adipocytes shift their secretory profile

-Pro-inflammatory cytokines: There is an overproduction of Leptin, TNF-α, and Interleukin-6 (IL-6).

-Anti-inflammatory cytokines: There is a significant decrease in Adiponectin, a protective hormone that normally enhances insulin sensitivity and exerts anti-atherogenic effects.

-Lipotoxicity : As adipose tissue becomes "overwhelmed," lipids spill over into non-adipose organs. This ectopic fat deposition in the liver and muscles is a primary trigger for systemic insulin resistance (Fahed et al., 2022).

II-4-2. Insulin Resistance (IR): The Metabolic Hub

Insulin resistance is defined as the impaired biological response of target tissues (liver, muscle, and adipose) to insulin.(Fahed et al., 2022) signaling pathway (specifically the PI3K/Akt pathway). This prevents the translocation of GLUT4 transporters, impairing glucose uptake and leading to postprandial hyperglycemia

Hepatic Impact: In the liver, insulin fails to suppress gluconeogenesis (glucose production), yet it continues to stimulate lipogenesis. This paradox leads to both fasting hyperglycemia and the development of Non-Alcoholic Fatty Liver Disease (NAFLD).

Compensatory Hyperinsulinemia: To maintain euglycemia, the pancreas secretes excessive amounts of insulin. MetS represents the stage where this compensation is active but eventually leads to β-cell exhaustion and Type 2 Diabetes(Fahed et al., 2022; Giangregorio et al., 2024).

II-4-3 Chronic Low-Grade Inflammation and Oxidative Stress

Metabolic syndrome is fundamentally a state of chronic low-grade systemic inflammation.

Macrophage Infiltration: Dysfunctional adipocytes recruit pro-inflammatory macrophages (M1 phenotype), which form "crown-like structures" around necrotic adipocytes, fueling the systemic release of inflammatory markers like C-reactive protein (CRP).

Oxidative Stress: Nutrient overload saturates mitochondrial capacity, increasing the production of Reactive Oxygen Species (ROS).), this oxidative stress causes cellular damage and further impairs insulin signaling, creating a self-perpetuating cycle of metabolic decay(« Pathophysiology-of-the-metabolic-syndrome-3 (1) », n.d.).

II-4-4. Clinical Consequences: Components of Metabolic Syndrome

These underlying pathophysiological mechanisms manifest clinically as the core components of metabolic syndrome:

-Atherogenic dyslipidemia: Increased free fatty acids (FFAs) delivered to the liver promote the overproduction of very-low-density lipoproteins (VLDL), resulting in elevated triglyceride levels, reduced high-density lipoprotein (HDL) cholesterol, and the formation of small, dense low-density lipoprotein (LDL) particles, which are highly atherogenic.

-Hypertension: Hyperinsulinemia and chronic inflammation activate the sympathetic nervous system and the renin–angiotensin–aldosterone system (RAAS), leading to sodium retention, increased vascular tone, and vasoconstriction.

-Endothelial dysfunction: Chronic low-grade inflammation reduces the bioavailability of nitric oxide (NO), resulting in impaired vasodilation and increased arterial stiffness.

Emerging Paradigms: Gut Microbiota and Metabolomics

Recent advances have introduced additional pathophysiological layers:

-Gut microbiota: Intestinal dysbiosis may lead to increased intestinal permeability ("leaky gut"), allowing bacterial lipopolysaccharides (LPS) to enter the circulation. This process promotes metabolic endotoxemia and systemic inflammation.

-Metabolic biomarkers: Elevated levels of branched-chain amino acids (BCAAs) and specific acylcarnitines are increasingly recognized as early metabolic signatures of mitochondrial dysfunction, often preceding the onset of clinical hyperglycemia(Fahed et al., 2022) (Ambroselli et al., 2023).

II-5. Clinical Manifestations and Diagnostic Criteria

II-5-1. Clinical Semiology and Physical Markers

Metabolic abnormalities in MetS are often asymptomatic in the early stages, they are accompanied by specific clinical signs that are highly predictive of major cardiovascular events.

Abdominal Obesity: Beyond being an anthropometric parameter, it reflects the accumulation of ectopic visceral fat, and represents the most visible and earliest manifestation of the syndrome.

Acanthosis Nigricans: This hyperpigmented, velvety skin condition—typically found on the neck or axilla—is a definitive clinical marker of compensatory hyperinsulinemia. It signifies severe peripheral resistance to insulin and must be systematically assessed during physical examination

Associated Systemic Manifestations: Beyond the classical criteria, MetS is frequently associated with "satellite" pathologies that share the same pathophysiological foundation:

- Non-Alcoholic Fatty Liver Disease (NAFLD): Now widely considered the hepatic manifestation of MetS

-Polycystic Ovary Syndrome (PCOS): A common endocrine manifestation in young women suffering from insulin resistance (Ambroselli et al., 2023; Després, 2012).

II-5-2. Biological Evaluation and Emerging Biomarkers

While positive diagnosis relies on standardized biochemical testing, the inclusion of emerging biomarkers allows for a more refined prognostic assessment(« Pathophysiology-of-the-metabolic-syndrome-3 (1) », n.d.).

-**Atherogenic Dyslipidemia:** It is characterized by hypertriglyceridemia and low HDL-cholesterol levels. Advanced analysis often reveals a predominance of small dense LDL (sdLDL) particles, which are particularly atherogenic.

-**Pro-inflammatory State (hs-CRP):** Although not included in official diagnostic criteria, measuring high-sensitivity C-reactive protein is highly recommended to quantify the low-grade inflammation and predict future coronary events .

-**Metabolomic Profiling:** Recent research highlights the significance of Branched-Chain Amino Acids (BCAAs) and specific acylcarnitines as early metabolic signatures of mitochondrial dysfunction that precede the onset of clinical hyperglycemia (Després, 2012; Giangregorio et al., 2024).

II-6. Associated complications

Metabolic syndrome represents a major public health challenge associated with significant premature morbidity and mortality primarily due to its link with cardiovascular disease and diabetes**(Després, 2012; Ngwasiri, Kinoré, Samadoulougou, & Kirakoya-Samadoulougou, 2023)**.

II-6-1. Cardiovascular and Metabolic Diseases

Type 2 Diabetes*:* Individuals with metabolic syndrome face a 5-fold increase in the risk of developing type 2 diabetes.

Cardiovascular Disease (CVD): There is a 2- to 3-fold increased risk for coronary heart disease (CHD) and myocardial infarction.

-Ischemic Stroke: The syndrome carries a similar 2- to 3-fold risk for future ischemic stroke.

-Atherosclerosis*:* Chronic inflammation and immune dysregulation associated with the syndrome contribute to accelerated atherogenesis, promoting the development of thrombosis.(Peterseim et al., 2024)

II-6-2. Obesity-Related Cancers (ORC)

Metabolic syndrome significantly increases the risk of several types of cancer and impacts patient survival.

Increased Incidence: Highly suggestive evidence links the syndrome to an increased risk of colorectal and renal cancers. It is also associated with postmenopausal breast, endometrial, liver, pancreatic, and esophageal adenocarcinoma.

Poorer Survival: The syndrome is associated with worsened survival rates for patients with colorectal cancer.

Dose-Response Relationship: The risk of complications, particularly for colorectal cancer, increases progressively with the number of abnormal metabolic components a patient possesses(Winn et al., 2026).

II-6-3. Neurological and Cognitive Impairment

Cognitive Deficits: Components like visceral obesity and hyperglycemia have detrimental effects on the brain, potentially leading to domentia. Microvascular dysfunction can damage hippocampal neurons, resulting in congnitive deficits

Neuropathy: Approximately **40–50% of patients** with idiopathic neuropathy also exhibit impaired glucose tolerance associated with metabolic syndrome. Injury mechanisms include fatty deposition in nerves and oxidative stress(« METABOLIC_SYNDROME_ASSOCIATED_COMPLICATI », n.d.).

II-6-4. Mental Health and Inflammatory Conditions

Depressive Disorders: There is a strong, often bi-directional correlation between metabolic syndrome and depression or anxiety. Pro-inflammatory cytokines released by adipose tissue can induce "sickness behavior" similar to clinical depression (Nerkar et al., 2015).

II-6-5. Arthritis:

Metabolic syndrome is independently associated with psoriatic arthritis and rheumatoid arthritis. The systemic inflammatory state of these conditions may further exacerbate cardiovascular risk (Nerkar et al., 2015).

II-7. Managemnet and Treatment of Metabolic Syndrome

The management of MetS is based on multifactorial and **integrated approach**, combing lifestyle modification, pharmacological treatment, and in some cases, surgical interventions. The main goal is to reduce the global cardiovascular risk and prevent type 2 diabetes .

According to the American Heart Association and the American College of Cardiology, management should follow an integrated cardiometabolic approach, targeting all risk factors in a coordinated and individualized manner, in line with recommendations from the American Diabetes Association and the European Society of Cardiology(Peterseim et al., 2024).

II-7-1. Intensive Lifestyle Modifications (First-Line Therapy)

Lifestyle changes are considered the cornerstone of MetS management and are often more effective than medication alone for diabetes prevention

Weight Loss Goals: For adults, a weight loss of 5% to 10% of initial body weight is generally recommended to significantly improve metabolic profiles

Dietary Patterns:

-Mediterranean Diet: Highly recommended for its ability to lower overall and cardiovascular mortality. It emphasizes high-quality olive oil, nuts (like almonds), vegetables, and lean fish According to the American Heart Association and the American College of Cardiology, management should follow an integrated cardiometabolic approach**,** targeting all risk factors in a coordinated and individualized manner, in line with recommendations from the American Diabetes Association and the European Society of Cardiology.

-Dietary Approaches to Stop Hypertension DASH Diet: Effective for reducing high blood pressure and improving metabolic profiles.

-Whole Foods: Diets high in colorful vegetables and low in processed or inflammatory foods are prioritized.

-Physical Activity: Regular moderate to vigorous physical activity is necessary. Effective programs range from high-intensity interval training (HIIT) to yoga and Tai Chi, all of which have been shown to reducethe the severity of the syndrome (Ambroselli et al., 2023; Peterseim et al., 2024).

II-7-2. Pharmacological Treatment

When lifestyle changes are insufficient, medications are used to treat individual components of the syndrome.

Weight Management & Diabetes Prevention:

-GLP-1 Receptor Agonists: Drugs like Semaglutide and Liraglutide are highly effective and can acheave ≥10% weight loss and improving HbA1C.

-SGLT-2 Inhibitors: Dapagliflozin, often in combination with Metformin, has been shown to induce MetS remission.

-Metformin: Frequently used for diabetes prevention, though it may be less effective than intensive lifestyle changes.

-Lipid Management: Statins are the standard for reducing atherosclerotic cardiovascular disease risk. **Fibrates** and nicotinic acid may be added, particularly to address high triglycerides and low HDL levels.

-Blood Pressure Control: ACE inhibitors and **Angiotensin-receptor blockers (ARBs)** are preferred because they may lessen the risk of developing new-onset diabetes. Combinations of beta-blockers and diuretics are generally avoided as they may worsen metabolic parameters (Peterseim et al., 2024).

II-7-3. Surgical Options

For patients with severe obesity, surgical interventions offer the most effective long-term weight loss outcomes.

Criteria: Bariatric surgery (such as laparoscopic sleeve gastrectomy) is recommended for individuals with a BMI >35 kg/m² or a BMI >30 kg/m² with a weight-related comorbidity.

Outcomes: Surgery has been shown to be superior to medical management alone for achieving glycemic control and MetS remission in patients with type 2 diabetes(Ambroselli et al., 2023)

II-7-4. Clinical Management in Primary Care

Primary care clinicians play a vital role by using behavioral techniques and regular counseling to motivate patients.

-Screening: Simple tools like measuring waist circumference serve as an essential first screening test for the syndrome.

-Behavioral Support: Quarterly primary care visits for lifestyle counseling and group-based weight loss interventions (like the US National Diabetes Prevention Program) have proven superior to self-directed efforts(Peterseim et al., 2024)

Part III :Association between COPD and Metabolic syndrome

III .1The prevalence of metabolic sundrome in patient with COPD:

Metabolic syndrome in increasingly recognized as a common comorbidity in patients with chronic obstructive pulmonary disease (COPD) .According to the Global Initiative for Chronic Obstructive Lung Disease , COPD is frequently associated with systemic manifestation that extend beyond the lungs. Epidemiological studies have consistently reported a higher prevalence of metabolic syndrome in COPD patients compared to the general population .The reported prevalence ranges between 20% and 50% , depending on the diagnostic criteria used and the characteristics of the study population .Criteria established by organizations such as the International Diabetes Federation (IDF) and the National Cholesterol Education Program are commonly used to define metabolic syndrome .Differences in these criteria contribute to the variability in prevalence estimates . Several cross-sectional and case -control studies have confirmed that COPD patients are at significantly increased risk of developing metabolic syndrome .Interestingly , the prevalence appears to be higher in patients with mild to moderate COPD. This may be explained by the presence of overweight or obesity in earlier stages of the disease .In contrast , advanced COPD in often associated with weight loss and muscle wasting , which may reduce the apparent prevalence of metabolic syndrome. Geographic and ethnic differences also influence prevalence rates .Lifestyle factors such as diet and physical activity further contribute to these variation .In addition, gender differences have been observed, with some studies suggesting a higher prevalence in female patients .The coexistence of metabolic syndrome in COPD patients represents a significant public health concern.It increases the overall disease burden and complicates clinical management . Early identification of metabolic syndrome in COPD patients is therefore essential. Screening strategies should be integrated into routine clinical practice .Understanding prevalence patterns helps guide preventive and therapeutic interventions .Overall, the high prevalence highlights the importance of considering COPD as a multisystem disease.

III-2. Shared Pathophysiological Mechanisms

The association between COPD and metabolic syndrome is largely explained by shared underlying pathophysiological mechanisms .One of the most important mechanisms is chronic systemic inflammation .COPD is characterized by persistent inflammation that extends beyond the respiratory system .Elevated levels of inflammatory markers such as C-reactive protein , interleukin-6, and tumor necrosis factor -alpha are commonly observed . These same markers are also involved in the development of metabolic syndrome. Visceral adipose tissue in metabolic syndrome release pro- inflammatory cytokines that contribute to systemic inflammation .This creates a common inflammatory pathway linking the two conditions .Oxidative stress is another key mechanism involved in both COPD and metabolic syndrome .In COPD , oxidative stress is mainly caused by exposure to cigarette smoke and environmental pollutants. It leads to airway damage and amplifies inflammation .In metabolic syndrome , oxidative stress contributes to insulin resistance and endothelial dysfunction .The imbalance between oxidants and antioxidants further worsens both conditions .Insulin resistance , a central feature of metabolic syndrome , has also been identified in COPD patients. It may occur independently of obesity, suggesting a direct effect of systemic inflammation .Reduced lung function has been associated with impaired glucose metabolism .Physical inactivity also plays a major role in linking these conditions .COPD patients often have reduced exercise capacity due to dyspnea and fatigue .This leads to a sedentary lifestyle, which promotes obesity and metabolic abnormalities .Hormonal and metabolic dysregulation further contribute to disease progression .Altogether, these interconnected mechanisms explain the strong biological link between COPD and metabolic syndrome

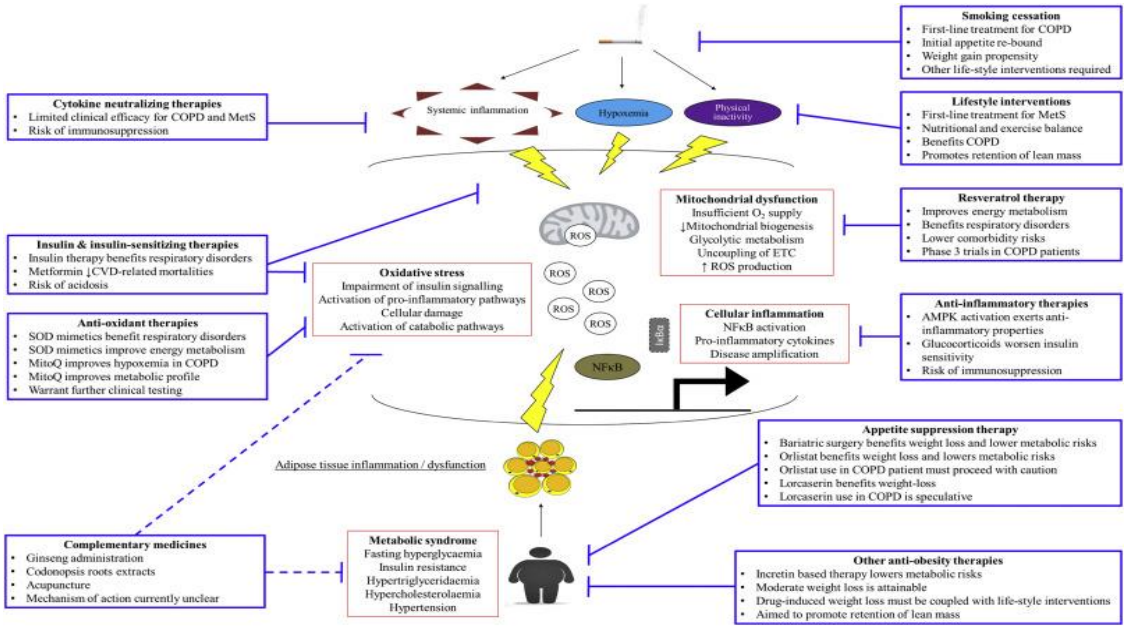


Figure 07: Pathobiological mechanisms underlying metabolic syndrome (MetS) in chronic obstructive pulmonary disease (COPD)

From : https://www.sciencedirect.com/science/article/pii/S0163725819300336

III-3. Contributing Risk Factors:

Several shared risk factors contribute to the coexistence of COPD and metabolic syndrome .Smoking is the most important risk factor for COPD and also plays a major role in metabolic disturbances . It promotes systemic inflammation and oxidative stress , which are central to both conditions. Aging is another significant factor , as the prevalence of both COPD and metabolic syndrome increases with age .Older individuals are more likely to accumulate multiple risk factors over time .Obesity , particularly central or abdominal obesity, is strongly associated with metabolic syndrome. In COPD patients , obesity is more commonly observed in early stages of the disease.

.It contributes to reduced lung function and increased inflammation. Physical inactivity is highly prevalent in COPD due to exercise limitation .This sedentary behavior increases the risk of weight gain , insulin resistance , and dyslipidemia . Dietary habits also play an important role with unhealthy diets contributing to metabolic imbalance .Long-term use of systemic corticosteroids in COPD management can lead to adverse metabolic effects . These

include hyperglycemia , hypertension , and increased fat deposition . Socioeconomic factors such as low income and limited access to healthcare may further increase risk . Environmental exposures, including air pollution , also contribute to both conditions .Genetic predisposition may influence susceptibility to metabolic syndrome in COPD patients Psychological factors such as depression and stress can indirectly affect lifestyle behaviors . Gender differences may also play a role in risk distribution . The interaction of these multiple factors creates a complex network that promotes disease coexistence .Identifying and addressing these risk factors is essential for prevention.

A comprehensive approach is required to reduce their impact.

III-4. Clinical Impact:

The coexistence of COPD and metabolic syndrome has significant clinical consequences . Patients with both conditions have a higher risk of cardiovascular diseases. These include coronary artery disease, hypertension, and stroke .Cardiovascular complications are among the leading causes of death in COPD patients . The presence of metabolic syndrome further increases this risk . COPD patients with metabolic syndrome often experience more severe symptoms .They may have increased dyspnea and reduced exercise tolerance . The frequency od acute exacerbation is also higher in this population . This leads to increased hospital admissions and healthcare costs . Metabolic syndrome negatively affects quality of life in COPD patients . The combined burden of respiratory and metabolic dysfunction results in greater physical limitation.0 It also contributes to psychological distress and reduced well-being . Studies have shown that these patients have higher mortality rates compared to those without metabolic syndrome. Functional capacity is often significantly impaired . The presence of comorbidities complicates disease management . It requires more intensive and multidisciplinary care. Inflammation and metabolic disturbances may accelerate disease progression . The overall prognosis is therefore worse . Early detection of metabolic syndrome is crucial to reduce complication . Regular monitoring of cardiovascular risk factor is recommended . Addressing comorbidities improves

patient outcomes. The clinical impact underscores the importance of integrated care.

III-5.Therapeutic Implications:

The recognition of the metabolic syndrome in COPD patients is very important, and its therapeutic implications are considerable. The therapy must not be restricted to the control of respiratory symptoms. Rather, the therapeutic approach must be multidisciplinary and comprehensive. The first and most important therapeutic intervention in the management of COPD is the cessation of smoking. Smoking cessation is also helpful in the reduction of the metabolic syndrome. Lifestyle modification is an important part of the therapy. Lifestyle modification must include the adoption of a healthy lifestyle, consisting of the consumption of a healthy diet and regular physical activity. Pulmonary rehabilitation is an important part of the therapy, especially in the case of COPD patients. Pulmonary rehabilitation is very helpful in the improvement of exercise tolerance and the reduction of the symptoms of dyspnea. Pulmonary rehabilitation is also helpful in the improvement of the metabolic syndrome. Weight reduction is an important part of the therapy, especially in the case of overweight and obese patients. The therapy must include the control of hypertension, diabetes, and dyslipidemia, and the judicious use of corticosteroids. The education of the patients is very important in the improvement of the compliance rate. The follow-up is very important in the monitoring of the progression of the disease and the appearance of comorbid conditions. The therapy must be multidisciplinary, and the therapeutic plan must be individualized. The preventive aspects must also be taken into consideration. The screening of the metabolic syndrome must be an important part of the therapy in COPD patients.

The association between COPD and metabolic syndrome is well established and supported by extensive scientific evidence . COPD is now recognized as a systemic disease with multiple comorbidities . Metabolic syndrome is one of the most common and clinically significant among them . The high prevalence of metabolic syndrome in COPD patients highlights the importance of this association . Shared pathophysiological mechanisms, including systemic inflammation and oxidative stress , play a central role . Insulin resistance and physical inactivity further strengthen the link between these condition . Common risk factors such as smoking , aging and obesity contribute to their coexistence . The clinical impact is substantial , with increased cardiovascular risk and mortality . Quality of life is significantly reduced in affected patients . The presence of metabolic syndrome complicates disease management . It requires a

comprehensive and multidisciplinary approach. Early detection is essential to prevent complications. Effective management should target both pulmonary and metabolic components . Lifestyle modification and risk factor control are key strategies . Pulmonary rehabilitation offers significant benefits. Integrated care can improve patient outcomes and prognosis. Future research is needed to better understand the underlying mechanisms . It may also help develop targeted therapies . Overall, addressing this association is crucial in modern COPD management

Practical Part

I- Objectives :

I- Objectives :

I-1. General objective :

To determine the prevalence of metabolic syndrome among patients with chronic obstructive pulmonary disease (COPD) in the region of Laghouat.

I-2. Specefic obgectives :

1 - To identify and describe the main comorbidities associated with copd in the study population .

2 - To assess the severity of COPD among patients with and without metabolic syndrome.

II. Materials and Methods

II-1. Study Design

This study was a cross-sectional, descriptive, and analytical study conducted to determine the prevalence of metabolic syndrome (MetS) among patients with chronic obstructive pulmonary disease (COPD) and to investigate its relationship with the severity of the disease.

A cross-sectional approach was adopted to evaluate both COPD characteristics and metabolic abnormalities at a single point in time. This design is considered appropriate for estimating the prevalence of metabolic syndrome in a defined population and for identifying possible associations between clinical and metabolic parameters.

The descriptive aspect of the study aimed to characterize the socio-demographic, clinical, and functional profile of COPD patients. Variables such as age, gender, smoking status, body mass index (BMI), respiratory symptoms, spirometric findings, and comorbidities were assessed. In addition, the presence of metabolic syndrome and its different components were evaluated according to established diagnostic criteria.

The analytical component of the study focused on examining the association between metabolic syndrome and COPD severity. Different indicators of disease severity, including GOLD stages, frequency of exacerbations, dyspnea level, and pulmonary function parameters, were analyzed in relation to the presence or absence of metabolic syndrome.

This methodological design allowed a comprehensive evaluation of the burden of metabolic syndrome among COPD patients and provided important clinical data regarding its potential impact on disease progression and severity.

II-1-2. Study Setting

The study was conducted in the Pulmonology Department and the Functional Exploration Department of Colonel Lotfi Hospital. These departments constitute specialized hospital units

dedicated to the diagnosis, evaluation, and management of respiratory diseases, particularly chronic obstructive pulmonary disease (COPD).

The Pulmonology Department receives a large number of patients suffering from chronic respiratory disorders and provides comprehensive clinical care, including medical consultations, hospitalization, therapeutic management, and long-term follow-up of COPD patients.

In parallel, the Functional Exploration Department plays a major role in the assessment of respiratory function through spirometric and functional investigations necessary for the diagnosis and classification of COPD severity according to established international recommendations.

This hospital setting was selected because of the availability of specialized medical staff, appropriate diagnostic facilities, and access to relevant clinical and functional data required for the study. In addition, the collaboration between both departments facilitated the collection of demographic, clinical, anthropometric, biological, and spirometric information necessary for evaluating the prevalence of metabolic syndrome and its association with COPD severity.

Conducting the study in this specialized tertiary healthcare center provided a reliable clinical environment for the assessment of COPD patients and ensured the accuracy and consistency of the collected data.

II-1-3. Study Timeline

The study was carried out over a period of seven months, from October 2025 to April 2026. This duration allowed sufficient time for patient recruitment, clinical evaluation, data collection, and assessment of metabolic and respiratory parameters among patients with chronic obstructive pulmonary disease (COPD).

Throughout the study period, eligible patients attending the Pulmonology Department and the Functional Exploration Department were consecutively included according to the predefined inclusion criteria. Clinical examinations, anthropometric measurements, spirometric

evaluations, and laboratory investigations were performed during this timeframe to ensure comprehensive assessment of both COPD severity and metabolic syndrome components.

The selected study period provided adequate conditions for obtaining reliable and representative data regarding the prevalence of metabolic syndrome among COPD patients and for analyzing its potential association with disease severity and clinical outcomes.

II-1-4. Study Population

The study population consisted of 18 patients diagnosed with chronic obstructive pulmonary disease (COPD) who attended the Pulmonology Department and the Functional Exploration Department of Colonel Lotfi Hospital during the study period.

All participants were previously diagnosed with COPD based on clinical evaluation and spirometric criteria in accordance with established international recommendations. The study included patients presenting different stages of disease severity in order to obtain a comprehensive clinical profile of COPD and to evaluate the prevalence of metabolic syndrome among this population.

The recruited patients underwent detailed clinical assessment, including demographic data collection, smoking history, anthropometric measurements, respiratory evaluation, and metabolic investigations. The study population was selected to explore the relationship between metabolic syndrome and COPD severity, as well as to assess the frequency of associated comorbidities and metabolic abnormalities in COPD patients.

Including patients from a specialized respiratory care setting ensured the availability of accurate clinical and functional data and contributed to the reliability of the study findings.

II-1-4-1. Inclusion Criteria

Participants were included if they met the following criteria :

Diagnosis of chronic obstructive pulmonary disease (COPD) according to the GOLD 2024 criteria, defined by persistent airflow limitation with a post-bronchodilator FEV_1/FVC ratio < 0.70 (See Diagnosis Part I : COPD).

Clinically stable condition for at least four weeks prior to inclusion, with no evidence of acute exacerbation or respiratory infection during this period.

Patients aged 40 years or older.

Patients able to undergo spirometric evaluation and metabolic assessment.

Provision of informed consent for participation in the study

II-1-4-2. Non-inclusion Criteria

· History of other chronic respiratory diseases such as asthma, bronchiectasis, interstitial lung disease, or active pulmonary tuberculosis.

· Presence of severe comorbidities likely to influence metabolic profile or respiratory function, including:

- Severe congestive heart failure (NYHA class III–IV)
- Severe chronic liver disease
- Severe chronic kidney disease (stage IV or V)
- Active malignancy or within the last five years
- Pregnancy or lactation.
- Inability to perform spirometry or undergo required metabolic tests.
- Refusal to give informed consent.

II-1-5. Diagnostic Criteria for Metabolic Syndrome:

Metabolic syndrome was defined according to the harmonized (JIS 2009) criteria (see Harmonized JIS definition, Part II: Metabolic Syndrome). The diagnosis required the presence of at least three of the following five components:

· Increased waist circumference: >94 cm in men or >80 cm in women.

· Elevated triglycerides: ≥150 mg/dL.

· Reduced HDL cholesterol:<40 mg/dL in men or <50 mg/dL in women.

· Elevated blood pressure: ≥130/85 mmHg or on antihypertensive treatment.

· Elevated fasting plasma glucose: ≥100 mg/dL or on antidiabetic medication.

II-1-6.Ethical Considerations

This study was conducted in strict compliance with ethical standards governing research involving human participants. Prior to the initiation of the study, ethical approval was obtained from the Ethics Committee of University of Amar Telidji(See Appendix N°IV) , ensuring that the study protocol met all required scientific and ethical guidelines. In addition, administrative authorization was granted by the management of Colonel Lotfi Hospital (See Appendix N°V), where the study was Before inclusion, all eligible patients were clearly informed, in understandable language, about the aim of the study, its procedures, and the type of data to be collected. Participants were also informed that the study involved no therapeutic intervention and that refusal to participate would not affect their medical follow-up or access to care in any way.

Informed consent was obtained from all participants prior to their enrollment in the study. This consent confirmed their voluntary agreement to participate after understanding the objectives and procedures of the research. Special attention was given to ensuring that consent was free of any coercion or pressure.

The study was conducted in accordance with the ethical principles of the Declaration of Helsinki, which emphasizes respect for human dignity, autonomy, beneficence, and non-maleficence in medical research involving human subjects. These principles guided all stages of the research process, from data collection to analysis.

Confidentiality was strictly maintained throughout the study. Each participant was assigned a unique code, and no personal identifiers were used during data analysis or presentation of results. All collected data were securely stored and accessed only by the research team. The information was used exclusively for scientific purposes and was not shared with any third party.

Finally, particular attention was given to protecting vulnerable patients and ensuring that all procedures were conducted in a respectful and professional manner, in accordance with international ethical standards for clinical research.

II-2. Data Collection and Variables

Data were collected over a seven-month period from October 2025 to April 2026 by medical interns trained in the study protocol (See Apeendix N°I) and working under the supervision of a senior pulmonologist. Patients attending regular follow-up consultations at the pulmonology department who fulfilled the inclusion criteria were consecutively recruited after obtaining informed consent. Each participant underwent a structured interview, a detailed clinical examination, and laboratory investigations using a standardized data collection form in order to ensure the consistency and reliability of the recorded information.

The following variables were collected and analyzed:

1.Demographic and socio-epidemiological characteristics:

Age (in years), sex (male/female), place of residence (urban or rural), and marital status were recorded for all participants.

2.Smoking history and exposure:

Smoking status was classified as current smoker, former smoker, or never smoker. For smokers and ex-smokers.

3.Anthropometric and clinical measurements:

Body weight and height were measured, and body mass index (BMI) was calculated in kg/m^2 according to the standard formula. Blood pressure was measured in a seated position after a period of rest using a calibrated sphygmomanometer, and systolic as well as diastolic blood pressure values (mmHg) were recorded. Clinical symptoms including dyspnea severity.

4.COPD parametres :

The duration of COPD since diagnosis (in years) was noted. Pulmonary function tests were performed according to standard spirometric procedures, including forced expiratory volume in one second (FEV_1), forced vital capacity (FVC), and the FEV_1/FVC ratio. The severity of airflow limitation was classified according to GOLD recommendations. The frequency of exacerbations during the previous year, history of hospitalization related to COPD exacerbations and associated respiratory symptoms were also documented.

4.Comorbidities and therapeutic management:

The presence of associated comorbidities such as diabetes mellitus, arterial hypertension, dyslipidemia, cardiovascular disease, obesity, and sleep disorders was recorded based on medical history and patient files. Current medications used for COPD management were documented, including bronchodilators, inhaled corticosteroids, combination therapies, antibiotics, and long-term oxygen therapy when applicable.

6.Biological and laboratory parameters:

Venous blood samples were collected after overnight fasting for biochemical analysis. Laboratory investigations included fasting blood glucose, Lipid profile (total cholesterol, triglycerides, high-density lipoprotein cholesterol (HDL-C)) , when available. Inflammatory status was assessed by measuring C-reactive protein (CRP) levels. These analyses were performed in the hospital laboratory according to standard laboratory procedures.

II-3. Measurement Instruments

• Weight: measured using a calibrated digital scale with an accuracy of ±0.1 kg. Patients were weighed barefoot and wearing light clothing.

• Height: measured using a wall-mounted stadiometer with an accuracy of ±0.5 cm. Patients stood upright without shoes, with heels together and head positioned in the Frankfurt horizontal plane.

• Waist circumference: measured using a non-elastic flexible tape measure, midway between the lower margin of the last palpable rib and the top of the iliac crest, with the patient standing and breathing normally. Measurements were recorded to the nearest 0.1 cm.

Blood pressure: measured using a validated automatic sphygmomanometer after at least 15 minutes of rest, in accordance with the 2024 ESC recommendations for standardized blood pressure assessment. Measurements were performed in a quiet environment with the patient seated comfortably, back supported, feet flat on the floor, and legs uncrossed. The arm was supported at heart level and an appropriately sized cuff was applied on the bare upper arm. Patients were instructed to avoid smoking, caffeine intake (McEvoy et al., 2024)

• Spirometry: performed using a COSMED portable desktop spirometer in patients who did not have or did not provide previous spirometry data. Testing was carried out according to standard spirometry procedures and quality control recommendations.

Figure 09 : validated automatic sphygmomanometer used in the study

From : https://www.med.tn/parapharmacie/omron-tensiometre-auto-brassard-m2-basic-5348.html

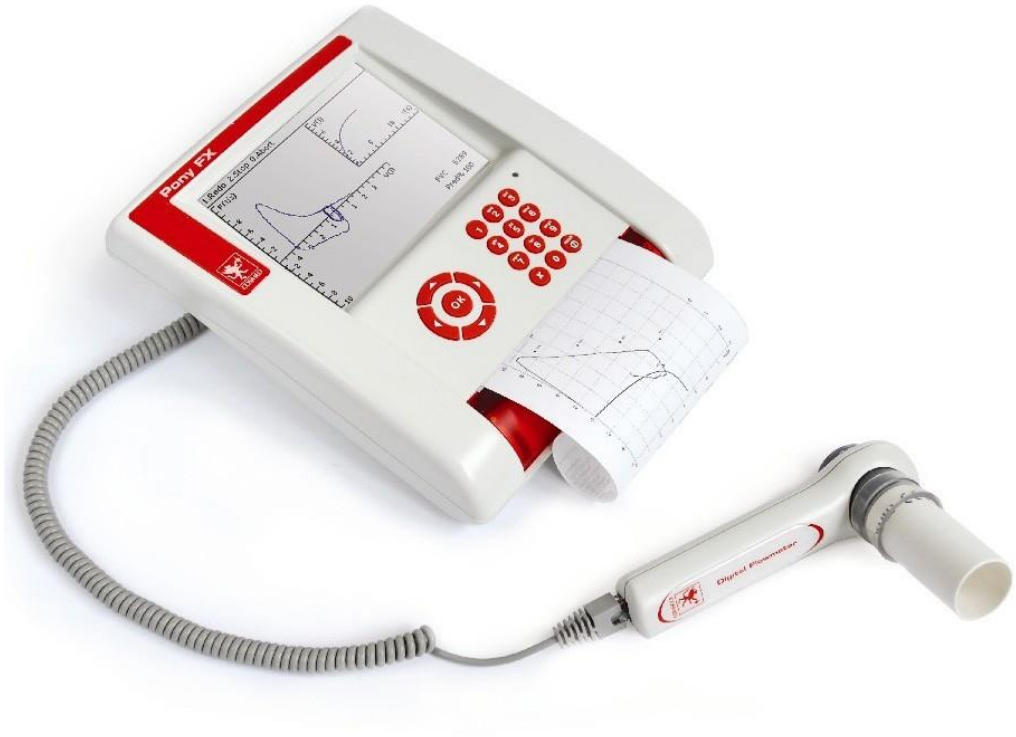


Figure 10 : COSMED Portable Desktop Spirometer

From : https://www.mediko.it/offerta/spirometro-pony-fx/

II-4. Laboratory Techniques

Blood samples were collected after an 8- to 12-hour fast. Analyses were performed in the hospital laboratory using the Mindray BS-240 (Mindray, China) automated biochemical analyzer, following standardized quality control protocols. The following biochemical parameters were measured:

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Fasting blood glucose

· Triglycerides

· HDL cholesterol

· C-reactive protein (CRP)

figure 11 : Mindray BS-240 (Mindray, China) automated biochemical analyzer

From :https://alliedhospitalsupply.com/product/mindray-bs-240/

II-5. Statistical Analysis

Statistical analysis was performed using SPSS and Sourcetable software.

· Descriptive statistics: Mean ± standard deviation (SD) or median for quantitative variables; frequencies and percentages for qualitative variables.

· Comparative analysis: Fisher's exact test for categorical variables (due to small sample size) and Student t-test for continuous variables.

· Significance level: $p<0.05$ was considered statistically significant.

III. RESULTS

III-1. Baseline characteristics of the study population (Table03)

A total of 18 COPD patients were included. There was a strong male predominance, with a male-to-female ratio of 17:1. The mean age was 65.6 ± 12.1 years. The mean BMI was 24.4 ± 6.4 kg/m², and the mean FEV_1 was 49.9 ± 13.2% of predicted value, reflecting moderate to severe airflow obstruction. Regarding COPD severity (GOLD stage), 7 patients (38.9%) were stage II, 9 patients (50.0%) were stage III, and 2 patients (11.1%) were stage IV.

Table 3: Baseline characteristics of the study population (N = 18) :

Variable	value
Demographic and clinical characteristics	
Age (years), mean ± SD	65.56 ± 12.11
BMI (kg/m²), mean ± SD	24.43 ± 6.42
FEV1 (% predicted), mean ± SD	49.89 ± 13.24
Sex, n (%)	
Male	17 (94.4)
Female	1 (5.6)
COPD severity (GOLD stage), n (%)	
GOLD II	7 (38.9)
GOLD III	9 (50.0)
GOLD IV	2 (11.1)

III-2. Prevalence of Metabolic Syndrome

Among the 18 COPD patients, metabolic syndrome was identified in 8 patients (44.4%), while 10 patients (55.6%) did not meet the diagnostic criteria.

III-3. Components of Metabolic Syndrome

Among patients with metabolic syndrome, the most frequent component was arterial hypertension, present in all 8 cases (100%). Elevated fasting blood glucose was found in 7 out of 8 patients (87.5%). Abdominal obesity and reduced HDL cholesterol were each observed in 5 out of 8 patients (62.5%). Elevated triglycerides were less common, affecting 3 out of 8 patients (37.5%)(See Table 04).

Table 04. Distribution of Metabolic Syndrome Components among Patients with Metabolic Syndrom :.

Component	n/8	%
Arterial hypertension (High BP see definition)	**8/8**	**100**
Elevated fasting blood glucose (or diabetes)	**7/8**	**87.5**
Abdominal obesity	**5/8**	**62.5**
Low HDL-cholesterol	**5/8**	**62.5**

Elevated triglycerides	**3/8**	**37.5**

III-4. Distribution of Comorbidities

The most frequent comorbidity was arterial hypertension (9/18, 50%), followed by cardiac disease (8/18, 44.4%), benign prostatic hyperplasia in male patients (5/17, 29.4%), diabetes mellitus (4/18, 22.2%), and a history of treated tuberculosis (3/18, 16.7%). Dyslipidemia and obstructive sleep apnea were recorded as isolated cases(See Table 05)

Table 05: Distribution of comorbidities in COPD patients (n = 18) :

Comorbidity	**n / N**	**%**
Hypertension	**9/18**	**50**
Cardiac disease	**8/18**	**44.4**
Benign prostatic hyperplasia (BPH)*	**5/17**	**29.4**
Diabetes mellitus	**4/18**	**22.2**
History of tuberculosis	**3/18**	**16.7**
Dyslipidemia	Low frequency**	-
Obstructive sleep apnea	Low frequency**	-

* BPH was assessed only in male patients (n = 17).

** Low frequency indicates isolated cases not quantified in the dataset

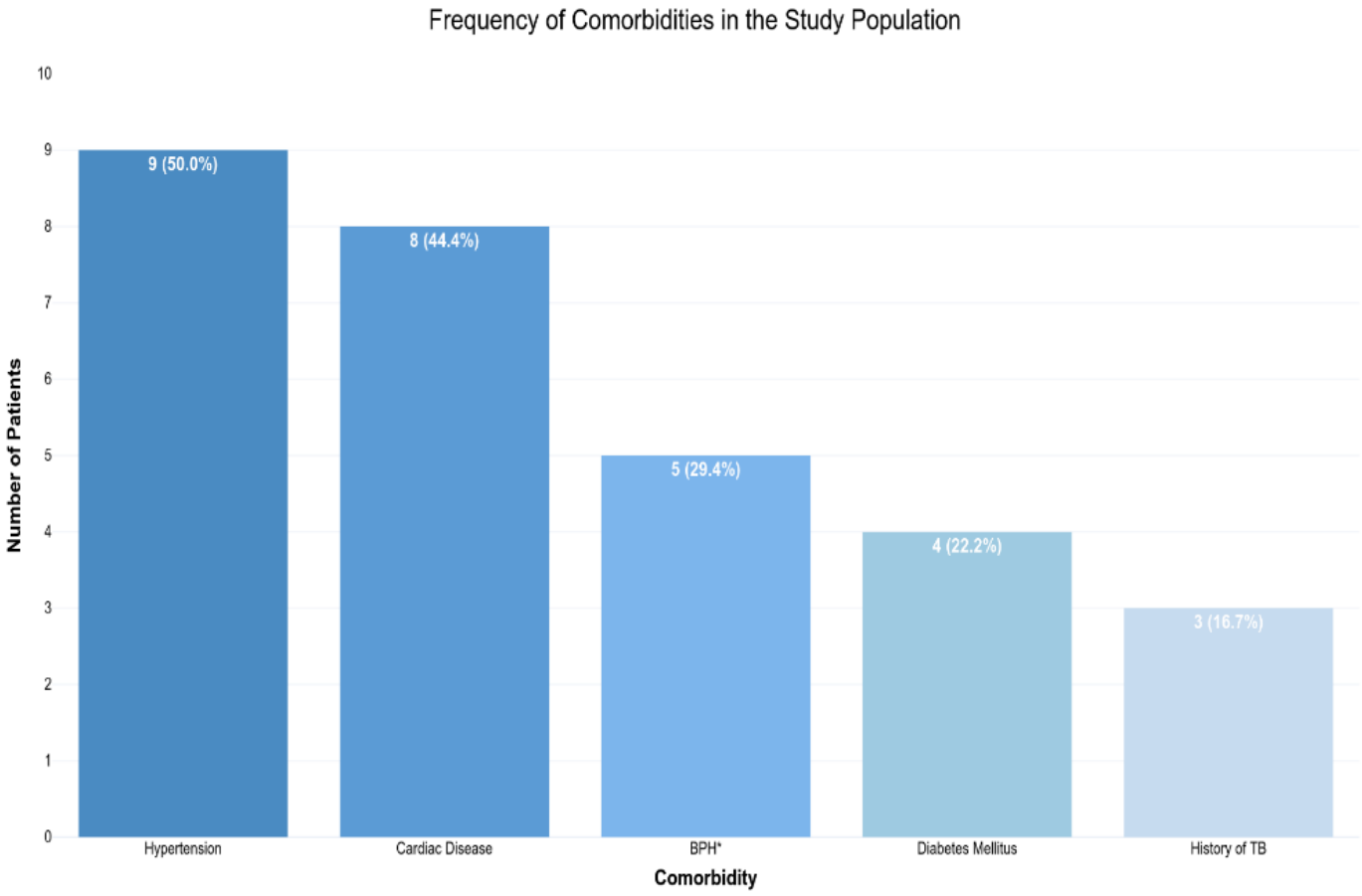


figure 12 : Distribution of Metabolic Syndrome Components Among Patients (n=8)

III-5. Association Between Metabolic Syndrome and Comorbidities

A statistically significant association was found between metabolic syndrome and hypertension (p = 0.015). Hypertension was present in 7 out of 8 patients (87.5%) in the MetS group compared to only 1 out of 10 (10%) in the non-MetS group. A significant association was also observed between metabolic syndrome and diabetes mellitus (p = 0.023); all four diabetic patients belonged to the MetS group. No significant association was found between metabolic syndrome and cardiac disease (p = 0.342)(See Table 06).

Table 06 : Association between Mets and comorbidities:

Comorbidity	MetS (n=8)	No MetS (n=10)	Statistical test	p-value	Interpretation
Hypertension	7 (87.5%)	1 (10%)	Chi-square / Fisher	0.015	Significant
Diabetes mellitus	4 (100% of diabetics in MetS)	0	Fisher exact test	0.023	Significant
Heart disease	5/8 (62.5% higher frequency trend)	3/10 (30% present but lower proportion)	Chi-square / Fisher	0.342	Not Significant

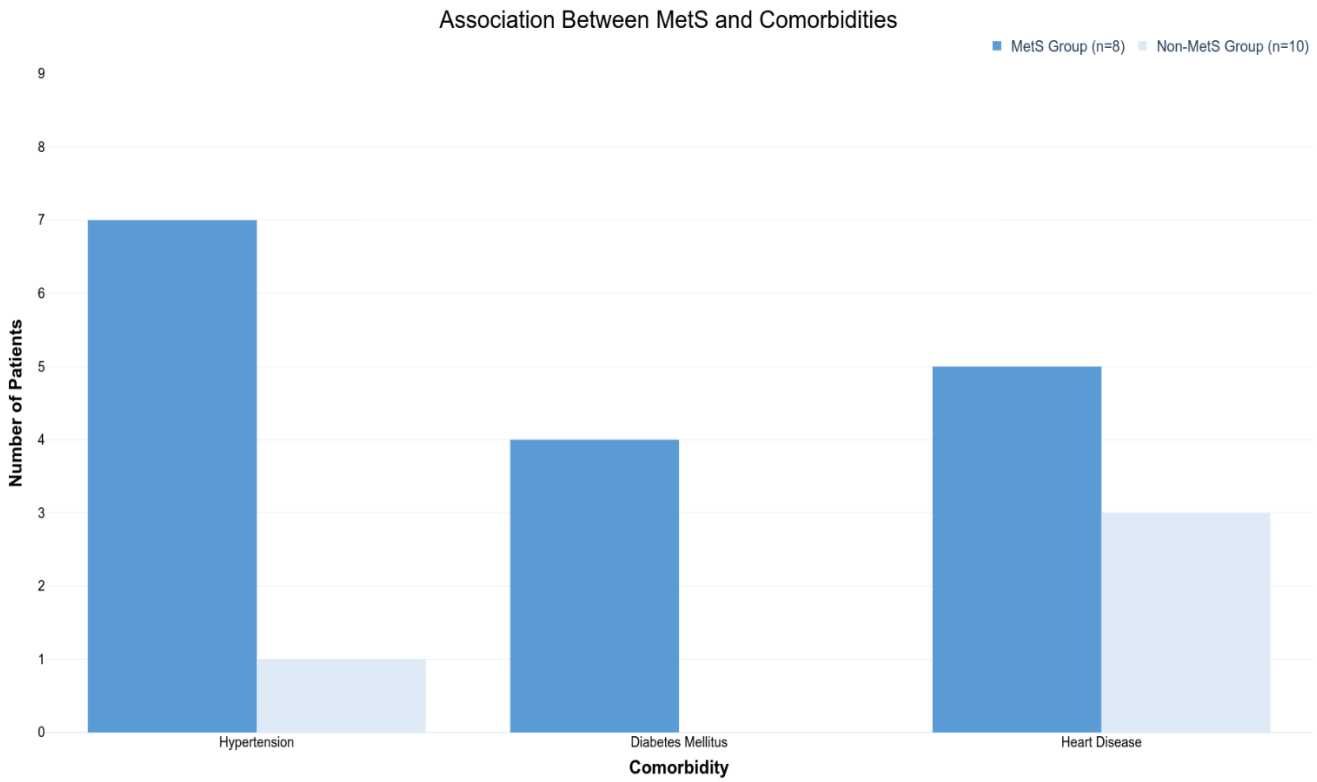


Figure 13 : Association between MetS and Comorbidities

III-6. Metabolic Syndrome, Lung Function, and Inflammatory Profile

No significant difference in FEV_1 was observed between patients with and without metabolic syndrome ($p = 0.529$). Similarly, no statistically significant association was found between metabolic syndrome and GOLD spirometric stage ($p = 0.552$).

When patients were reclassified according to the GOLD ABE system, a statistically significant association was demonstrated between metabolic syndrome and disease phenotype ($p = 0.011$), confirmed by Fisher's exact test ($p = 0.004$). A progressive increase in the prevalence of MetS was observed from group A to group E, with the highest proportion in the E group.

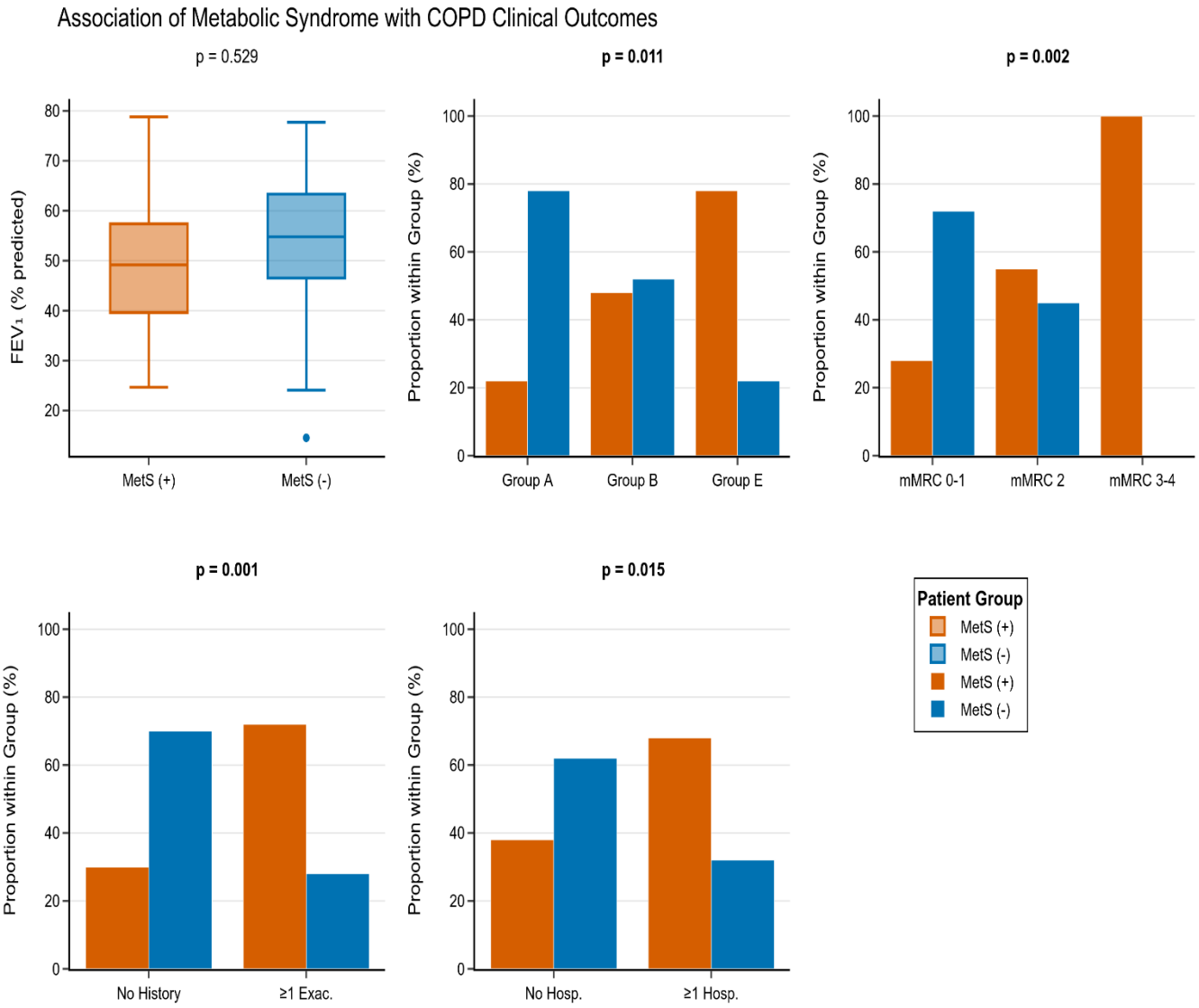
A strong and statistically significant association was also found between metabolic syndrome and dyspnea severity assessed by the mMRC scale ($p = 0.002$), with all patients presenting severe dyspnea (mMRC stages 3 and 4) belonging to the MetS group.

No significant association was found between metabolic syndrome and CRP levels ($p = 0.453$), although higher CRP values tended to be more frequent in patients with MetS.

Importantly, metabolic syndrome showed a significant association with COPD clinical outcomes, including a history of exacerbations ($p = 0.001$) and hospitalization due to exacerbations ($p = 0.015$). These associations were particularly evident in patients classified in the GOLD ABE group (See Table 07).

Table 07: metabolic syndrome and lung function/ inflammatory profile in COPD patient :

Parametre	**Statistical test**	**χ^2 value**	**df**	**p-value**	**Result**
FEV1	Pearson Chi-square	13.950	15	0.529	Not significant
GOLD stage	Pearson Chi-square	1.189	2	0.552	Not significant
Dyspnea (mMRC)	Pearson Chi-square	15.300	3	0.002	**S**ignificant
CRP	Pearson Chi-square	13.950	14	0.453	Not significant
Exacerbation	Pearson Chi-square / Fisher	10.811	1	0.001	**Significant**
Hospitalization	Pearson Chi-square / Fisher	5.951	1	0.015	**Significant**
Gold ABE	Pearson Chi-square/ Fisher-freemam-Halton	9.000	2	0.004	**Significant**



(A) Boxplot comparing FEV_1 (% predicted) between COPD patients with and without metabolic syndrome (MetS), showing no significant difference (p = 0.529).

(B) Clustered bar chart showing the distribution of MetS across GOLD ABE groups, with a progressive increase in prevalence from group A to group E (p = 0.011; Fisher's exact test p = 0.004).(C) Clustered bar chart showing the association between MetS and dyspnea severity (mMRC scale), with higher prevalence of MetS in severe dyspnea (mMRC 3–4) (p = 0.002).

(D) Clustered bar chart showing the association between MetS and history of COPD exacerbations (p = 0.001).

(E) Clustered bar chart showing the association between MetS and hospitalization due to exacerbations (p = 0.015).

Values are expressed as percentages within groups. A p-value < 0.05 was considered statistically significant

Figure 14 : Association between metabolic syndrome and clinical, functional, and prognostic parameters in COPD patients.

IV DISCUSSION

IV DISCUSSION:

The main finding of this study is that metabolic syndrome is highly prevalent among patients with COPD in the Laghouat region, affecting nearly one out of every two patients (44.4%). This result directly answers the primary research question and confirms that MetS represents a frequent and clinically relevant comorbidity in this population. The high frequencies of hypertension (50%), cardiac disease (44.4%), and diabetes (22.2%) further demonstrate a clear clustering of cardiometabolic risk factors, reflecting the systemic nature of COPD beyond the respiratory tract.

The observed prevalence of MetS (44.4%) is higher than that reported in the general Algerian population, where recent data indicate a prevalence of approximately 30–35% among adults. This confirms that COPD patients constitute a high-risk group for metabolic disorders in Algeria. Our results are also consistent with international literature, particularly a meta-analysis by Cebron Lipovec et al. (2016) which reported a MetS prevalence of 30–50% in COPD patients worldwide. More recent studies have similarly found that MetS is associated with worse clinical outcomes without necessarily being correlated with FEV_1.

A particularly noteworthy finding of our study is the dissociation between pulmonary function and clinical outcomes. While no significant association was found between MetS and FEV_1 or GOLD stage, a strong and significant association was observed with dyspnea severity ($p = 0.002$), exacerbations ($p = 0.001$), and hospitalizations ($p = 0.015$), and this pattern was further supported by the GOLD ABE classification, which also showed a significant association with MetS ($p = 0.011$, confirmed by Fisher's exact test $p = 0.004$), with a higher prevalence of metabolic syndrome particularly in the GOLD E group characterized by frequent exacerbations and increased disease severity. This suggests that metabolic syndrome influences the clinical course of COPD mainly through systemic and functional pathways—such as chronic inflammation, insulin resistance, and reduced exercise tolerance—rather than through the degree of airflow limitation itself

The significant association between MetS and hypertension and diabetes was expected, as these conditions are integral components of the metabolic syndrome definition. The fact that all hypertensive and diabetic patients clustered within the MetS group reinforces the internal consistency of our diagnostic approach. However, the absence of a significant association with cardiac disease ($p = 0.342$) may be explained by the small sample size or by the fact that

cardiac disease was recorded regardless of its etiology, not specifically as ischemic heart disease related to metabolic disturbances.

Regarding inflammatory status, no significant association was found between MetS and CRP levels ($p = 0.453$), although a trend toward higher CRP values was observed in the MetS group. The lack of statistical significance may be due to the small sample size or to the fact that CRP is a nonspecific marker that can be elevated in COPD irrespective of metabolic status.

Strengths and limitations

This study has several strengths, including the use of real-world clinical data from an Algerian hospital setting, the application of standardized international criteria for both COPD (GOLD 2024) and MetS (harmonized JIS 2009 criteria), and the simultaneous collection of functional,clinical, and biological parameters.

However, several limitations must be acknowledged. The small sample size ($n = 18$) limits statistical power and precludes subgroup analyses or multivariate adjustment. The cross-sectional design does not allow causal inference; we can only describe associations, not

determine whether MetS worsens COPD or vice versa. In addition, some comorbidities were recorded as low-frequency variables, which may underestimate their true prevalence. Finally, the single-center nature of the study limits the generalizability of our findings to other regions of Algeria.

Clinical implications

From a practical standpoint, our findings underscore the importance of systematic screening for metabolic syndrome in all patients with COPD, regardless of their spirometric severity. Routine assessment of blood pressure, fasting glucose, lipid profile, and waist circumference should be integrated into COPD management protocols. A multidisciplinary approach involving pulmonologists, cardiologists, and endocrinologists is essential to optimize the management of these patients and to reduce the risks of exacerbations, hospitalizations, and cardiovascular events.

Future perspectives

Future research should include larger, multicenter studies in Algeria and North Africa to better characterize the association between COPD and metabolic syndrome. Longitudinal studies are needed to establish causal relationships and to evaluate whether targeted interventions—such as lifestyle modification programs, optimized cardiometabolic treatment, or specific antidiabetic agents (e.g., GLP-1 agonists, SGLT-2 inhibitors)—can reduce exacerbation rates, hospitalizations, and improve quality of life in COPD patients with

metabolic syndrome.

V.Conclusion

Conclusion:

This study aimed to determine the prevalence of metabolic syndrome among patients with chronic obstructive pulmonary disease (COPD) and to assess its clinical impact.

The results showed that metabolic syndrome is frequent in this population, affecting nearly half of the patients, indicating a substantial burden of cardiometabolic disorders among individuals with COPD. The high prevalence of hypertension, cardiac disease, and diabetes further highlights the clustering of comorbidities and supports the concept of COPD as a systemic disease.

Although no significant association was observed between metabolic syndrome and airflow limitation severity (FEV_1 or GOLD stage), a strong relationship was found with clinical outcomes. Patients with metabolic syndrome presented more severe dyspnea, as well as a higher frequency of exacerbations and hospitalizations. These findings suggest that metabolic syndrome primarily influences COPD through its systemic and functional impact rather than through spirometric severity.

Compared with the general population, the prevalence of metabolic syndrome in COPD patients appears higher, reinforcing the idea that this population represents a high-risk group requiring specific attention.

Despite its limitations, particularly the small sample size and cross-sectional design, this study provides valuable insight into the interaction between COPD and metabolic disorders in a real-world clinical setting.

In conclusion, metabolic syndrome is a common and clinically relevant comorbidity in COPD, associated with worse disease outcomes. These findings underline the importance of systematic screening and comprehensive management of metabolic risk factors in COPD patients.

From a clinical perspective, an integrated and multidisciplinary approach involving pulmonologists, cardiologists, and endocrinologists is essential to improve patient prognosis and reduce disease burden.

Future research should focus on larger, multicenter studies and longitudinal designs to better understand causal relationships and to evaluate the impact of targeted interventions on clinical outcomes

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4. https://www.mdpi.com/1422-0067/23/2/786 **Pathophysiologie of MetS**

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6. https://www.med.tn/parapharmacie/omron-tensiometre-auto-brassard-m2-basic-5348.html **sphygmomanometer used in the study**

7. https://www.mediko.it/offerta/spirometro-pony-fx **COSMED Spirometer**

List of Appendix

ABSTRACT

Theme: Prevalence of metabolic syndrome among patients with chronic obstructive pulmonary disease (COPD) in the region of Laghouat.

Authors: **Nafti Rania Dalila / Beroman Nihal Mariane**

Key words: COPD, metabolic syndrome, prevalence, comorbidities, exacerbations.

Objectives:

ü To determine the prevalence of metabolic syndrome among patients with COPD;
ü To assess the association between metabolic syndrome and COPD severity;
ü To identify and describe the main comorbidities associated with COPD.

Materials and Methods:

This is a cross-sectional descriptive and analytical study conducted over a period of seven months, from july 2025 to April 2026, in the pulmonology department of Colonel Lotfi Hospital in Laghouat. The study included 18 patients diagnosed with COPD according to GOLD 2024 criteria.

Metabolic syndrome was defined based on harmonized criteria, requiring the presence of at least three metabolic abnormalities. Clinical, functional, and biological data were collected using a standardized data collection form. Statistical analysis was performed using SPSS and Sourcetable software, with a significance level set at $p < 0.05$.

Results:

The prevalence of metabolic syndrome was 44.4% (8 out of 18 patients).
The most frequent comorbidities were hypertension (9/18), heart disease (8/18), and diabetes mellitus (4/18).

No significant association was found between metabolic syndrome and airflow limitation severity (FEV_1 or GOLD stage). However, metabolic syndrome was significantly associated with dyspnea severity ($p = 0.002$), exacerbations ($p = 0.001$), and hospitalization ($p = 0.015$).

Conclusion:

Metabolic syndrome is common among patients with COPD and is associated with worse clinical outcomes, particularly increased dyspnea, exacerbations, and hospitalization.

These findings highlight the importance of systematic screening and integrated management of metabolic comorbidities in COPD patients through a multidisciplinary approach to improve prognosis and reduce disease burden

Apeendix N°I :

Research Protocol

People's Democratic Republic of Algeria

Ministry of Higher Education and Scientific Research

University of Amar Tlidji – Faculty of Medicine

RESEARCH PROTOCOL

Title: Prevalence of Metabolic Syndrome among Patients with COPD Followed at Laghouat Hospital

Submitted by:

Beroman Nihel Marianne

Nafti Rania Dalila

7th-Year Medical Students

Suprvised by :

Dr. HAITHAM SIGA

Dr.LITIM

Academic Year: 2025–2026

Place: Laghouat

Year: 2025

Table of Contents

1/Introduction :

Chronic Obstructive Pulmonary Disease (COPD) is the third leading cause of death worldwide, characterized by persistent airflow limitation and chronic airway inflammation. Active smoking remains the main risk factor, but other factors are becoming better known, such as occupational factors, infections, and the role of air pollution. Among these comorbid conditions, Metabolic Syndrome (MS) has gained substantial attention in recent years and represents a cluster of interrelated metabolic disturbances that increase the risk of cardiovascular disease and type 2 diabetes mellitus. The prevalence of MS is notably higher among patients with COPD compared to the general population, suggesting a potential pathophysiological link between the two disorders

2/Problem statement :

Recent studies have shown that metabolic syndrome is common among patients with Chronic Obstructive Pulmonary Disease and may have a significant impact on their prognosis and quality of life.
However, in Algeria, and particularly in the region of Laghouat, data remain scarce regarding the coexistence of these two conditions.
This gap in knowledge motivated us to determine the prevalence of Metabolic Syndrome among COPD patients in Laghouat

3. Hypotheses

The prevalence of Metabolic Syndrome is high among patients with Chronic Obstructive Pulmonary Disease.

There is a significant association between the presence of metabolic syndrome and COPD-related comorbidities (such as cardiovascular diseases and diabetes).

The severity of COPD is positively associated with the presence of metabolic syndrome, with more severe COPD patients being more likely to present metabolic syndrome

4/Study objectives :

A - General objective :

To determine the prevalence of metabolic syndrome among patients with chronic obstructive pulmonary disease (COPD) in the region of Laghouat.

B - Specefic objectives :

· To estimate the prevalence of metabolic syndrome in COPD patients.

· To identify the frequency of comorbidities (such as cardiovascular diseases and diabetes) among COPD patients with metabolic syndrome.

· To evaluate the association between COPD severity and the presence of metabolic syndrome.

5 /Literature Review:

Chronic Obstructive Pulmonary Disease (COPD) is a chronic respiratory disease characterized by persistent airflow limitation and progressive decline in lung function. Beyond its pulmonary manifestations, COPD is increasingly recognized as a systemic disease associated with multiple comorbidities.

Among these comorbidities, Metabolic Syndrome has been widely studied due to its impact on cardiovascular risk and overall prognosis. Metabolic syndrome is defined as a cluster of metabolic abnormalities, including hypertension, diabetes mellitus, abdominal obesity, and dyslipidemia. It reflects a state of chronic low-grade inflammation and insulin resistance.

Several studies have demonstrated that metabolic syndrome is more frequent in COPD patients compared to the general population. In Algeria, recent national data estimate the prevalence of metabolic syndrome in adults at approximately 30–35%. Similar rates have been reported in other North African countries, including Tunisia and Morocco, where prevalence ranges between 30% and 35%.

International studies further support a strong association between COPD and metabolic syndrome. A meta-analysis by Cebron Lipovec et al. (2016) reported that metabolic syndrome affects approximately 30–50% of COPD patients worldwide. These studies also highlight that metabolic syndrome is associated with worse clinical outcomes, including increased dyspnea, higher risk of exacerbations, and more frequent hospitalizations, although its relationship with airflow limitation (FEV1) remains inconsistent.

More recent evidence confirms that COPD patients with metabolic syndrome tend to have a more severe clinical course and increased healthcare utilization, supporting the concept that COPD is a systemic disease rather than a condition limited to airway obstruction

6 / Methodology :

A - STUDY SETTING :

The study will be conducted in the pulmonology ward of COLONEL LOTFI HOSPITAL / TB AND RESPIRATORY DISEASES UNIT .

B - STUDY DESIGN :

This is a cross-sectional descriptive and analytical study designed to determine the prevalence of Metabolic Syndrome among patients with Chronic Obstructive Pulmonary Disease (COPD) and to assess its association with disease severity

C - STUDY PERIOD :

From November 2025 To April 2026

D - STUDY POPULATION :

D - 1 -Inclusion Criteria

Participants will be included in the study if they meet the following criteria

-Diagnosed with Chronic Obstructive Pulmonary Disease (COPD) according to the GOLD 2024 criteria (post-bronchodilator FEV/FVC < 0.7).

-Clinically stable for at least four weeks prior to inclusion (no acute exacerbation).

Diagnostic criteria of Metabolic Syndrome

- Diagnosis with Metabolic Syndrome (MetS) according to the harmonized definition

The presence of at least three of the following components:

- Waist circumference >94cm (men) or >80 cm (women).

- Triglycerides ≥150 mg/dL.

- HDL cholesterol <40 mg/dL (men) or <50 mg/dL (women).

- Blood pressure ≥130/85 mmHg or on antihypertensive treatment.

- Fasting plasma glucose ≥100 mg/dL or on antidiabetic medication.

-Patients who provide written informed consent to participate in the study.

D -2-Non inclusion Criteria

- History of other chronic respiratory diseases such as asthma, bronchiectasis, interstitial lung disease, or active pulmonary tuberculosis.

-Presence of severe comorbidities likely to influence the metabolic profile or respiratory function, such as:

- severe Congestive heart failure (NYHA class III–IV)

- severe Chronic liver disease

- severe Chronic kidney disease (stage IV or V)

- Malignancy (active or recent within 5 years)

- Pregnant or lactating women .

- Inability to perform spirometry or undergo required metabolic tests.

- Refusal to give informed consent

E - Techniques and Tools for Data Collection :

E -1- Mode of Data Collection and Schedule

Data will be collected over a period of six months, from November 2025 to April 2026.

The collection will be conducted by tow interns under the supervision of the pulmonologist

Each patient meeting the inclusion criteria will be interviewed and examined during pulmonology consultation

Information will be recorded on a structured data collection sheet, including sociodemographic, clinical, biological and post broncho dilatation spirometric values .

E -2-Diagnosis of COPD

-Diagnosed with Chronic Obstructive Pulmonary Disease (COPD) according to the GOLD 2024 criteria (post-bronchodilator FEV/FVC < 0.7).

E -3- Measurement Instruments :

Anthropometric measurements:

Weight: digital scale (accuracy ±0.1 kg)

Height: stadiometer (accuracy ±0.5 cm)

Waist circumference: flexible tape measure (measured midway between the last rib and iliac crest)

Blood pressure: automatic sphygmomanometer after 15 minutes of rest

E- 4 - Laboratory Techniques :

Blood samples will be drawn after 8–12 hours of fasting and analyzed in the hospital laboratory using automated biochemical analyzer MINDRAY SIT 240 , according to standard operating procedures and internal quality controls.

-Fasting blood glucose

-Triglycerides

-HDL cholesterol

Ethical and Administrative Considerations :

1- Administrative Authorization

Before starting data collection, official authorization will be obtained from the administration of Laghouat Hospital and the Pulmonology Department where the study will be conducted.

All members of the research team will be introduced to the medical staff, and data collection will take place in coordination with the department head to ensure smooth organization and respect for hospital functioning

2- Ethical Approval

The study protocol will be submitted to the Ethics Committee of Laghouat University / Laghouat 'Hospital for ethical approval prior to implementation.

All study procedures will conform to the ethical principles outlined in the Declaration of Helsinki (2024 revision) and to national regulations concerning biomedical research involving human participants.

3- Informed Consent

Participation in this study will be entirely voluntary.

Each patient will receive clear and complete information about:

The purpose of the research

The procedures involved,

The potential risks and benefits, and their right to withdraw at any time without any consequence on their medical care.

Oral and written informed consent will be obtained from every participant before data collection begins.

4-Confidentiality and Data Protection

Each participant will be assigned a unique identification code. No names or personal identifiers will be recorded in the database.

All data will be kept strictly confidential,and accessible only to the main investigators.

The study results will be presented anonymously and used exclusively for scientific and educational purposes.

5-Riscks and Benefits

The study involves minimal risk to participants, limited to routine procedures such as blood sampling and spirometric testing.

The potential benefits include better detection and management of metabolic abnormalities and comorbidities in COPD patients.

No financial compensation will be offered; however, all participants will be treated with respect and care

Statistical Analysis Plan

.Software:

SPSS and Sourcetable

.Descriptive statistics:

Mean ± SD or median (IQR) for quantitative variables; percentages for qualitative variables.

.Comparative analysis:

- Chi-square test or Fisher's exact test for categorical variables.

- Student's t-test or Mann–Whitney U test for continuous variables.

.Multivariate analysis:

Logistic regression to identify independent predictors of Metabolic Syndrome.

Significance level: $p < 0.05$

Judgement Criteria

Study Endpoint:

The primary endpoint: of this study is to determine the prevalence of metabolic syndrome among patients with chronic obstructive pulmonary disease (COPD

secondary endpoints

The secondary endpoints include:

To evaluate the **association between metabolic syndrome and the severity of COPD**, assessed by spirometric parameters (FEV1) and GOLD classification.

To assess the **relationship between metabolic syndrome and clinical outcomes**, including dyspnea severity (mMRC scale), frequency of exacerbations, and hospitalization.

To describe the **distribution of cardiometabolic comorbidities**, including hypertension, diabetes mellitus, and cardiovascular diseases in COPD patients.

To compare the **prevalence of metabolic syndrome in COPD patients with that reported in the general population**

6/Study Calendar :

The study will be conducted over a total period of 10 months, with the main phases organized as follows:

Study Phase Duration Main Activities

Preparation and Ethical Approval

Months 1–2 - Finalization of study protocol

- Submission to and approval by the Institutional Ethics Committee

- Training of the research team

_Participant Recruitment

Months 3–8 - Screening of patients according to inclusion/exclusion criteria

- Obtaining informed consent

- Scheduling visits and assessments

Clinical and Laboratory Data Collection

Months 3–9 - Collection of demographic and clinical data

- Anthropometric measurements and pulmonary function tests

- Blood sampling for metabolic profile

Data Entry and Verification

Months 6–10 - Entry of data into SPSS database

- Quality control and data validation

Statistical Analysis

- Evaluation of associations between COPD and Metabolic Syndrome

Report Writing / Finalization

- Writing of study report and conclusions

- Preparation for publication or defense

Apeendix N°II :

Information Sheet

Information sheet - The Prevalence of Metabolic Syndrom among COPD Patients :

I. Patient Information

1 - Patient ID : ---------- / 2 - Age : ---------- Years old

3 - sex : ☐Male ☐Female / 4 - Adress : ----------

5 - Phone number ---------- / 6 - Informed Consent : ☐

7 - Occupation ----------

8 - Marital Status : ☐Single ☐ Married ☐Widowed

9 - Smoking Status : ☐Current ☐Former ☐Never / 10 - Pack-years : ----------

II. Anthropometric Measurements

11- Height (cm) : ---------- / 12- Weight (kg) : ----------

13 - BMI (kg/m²) : ---------- / 14 - Waist circumference (cm) : ----------

15 - Blood Pressure (mmHg) : ------ / ------

III. COPD Clinical Data

16- Duration of COPD (years) : ---------- / 17 - FEV1 (% predicted) : --------

18 - GOLD Stage : ☐I ☐II ☐III ☐ / 19 - Exacerbations (past 12 months) :-----

20 - Hospitalizations (past 12 months) : -------- / 21 - Oxygen therapy : ☐Yes ☐No

22- Dyspnea mMRC : 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐

- IV. Comorbidities

23-☐Hypertension ☐Diabetes ☐Dyslipidemia ☐Cardiovascular disease (IHD / HF)
☐Tuberculosis ☐Depression / Anxiety ☐Sleep apnea ☐Cancer ☐Anemia
☐Other: _____

V. Laboratory Data

24- Fasting glucose : ---------- mg / L / 25 - Triglycerides : ---------- mg / L

26HDL cholesterol : ---------- mg / L / 27-CRP -------mg/L ESR -------mm

VI. Metabolic Syndrome (Harmonized Definition 2009)

29 -Waist circumference ♂≥94 cm / ♀≥80 cm ☐Yes ☐No

30- Triglycerides : ≥ 150 mg/dL or treated ☐Yes ☐No

31 - HDL cholesterol : <40mg / dL M / <50 F or treated ☐Yes ☐No

32 - Blood pressure : ≥130/85 mmHg or treated ☐Yes ☐No

33- Fasting glucose :≥100 mg/dL or diabetes ☐Yes ☐No

34 - Metabolic Syndrome Present: ☐Yes ☐No No. of Criteria Met: ____

VII. Current Treatment

35- For Diabetes: ☐None ☐Diet ☐Oral agents ☐Insulin ☐Other: _____

36- For Hypertension: ☐None ☐ACE inhibitors ☐ARBs ☐Beta-blockers ☐Calcium blockers ☐ Diuretics ☐Other: _____

37 -For Dyslipidemia: ☐None ☐Statins ☐Fibrates ☐Other: _____

VIII. Notes / Observatiion :

Data Collector: _____ Signature: _____

Appendix N°III :

Hospital Authorization for Conducting The Study

Hôpital Mixte de Laghouat

Laghouat, le 09 . 03 . 2026

ÀMonsieur le Directeurde l'Hôpital Mixte de Laghouat

Objet : Demande d'autorisation pour la réalisation d'une étude dans le cadre d'unmémoire

Monsieur le Directeur,

Dans le cadre de la préparation de notre mémoire de fin d'études en médecine, encadré par Dr Sigaa et Dr Litim, nous avons l'honneur de solliciter votre bienveillance afin d'obtenir l'autorisation de réaliser une étude au sein de l'Hôpital Mixte de Laghouat.

Cette étude, intitulée : « Prévalence du syndrome métabolique chez les patients atteints de bronchopneumopathie chronique obstructive (BPCO) dans la région de Laghouat », a pour objectif d'évaluer la fréquence du syndrome métabolique chez les patients atteints de BPCO, ainsi que d'analyser les différents facteurs associés.

La réalisation de ce travail nécessitera la collaboration de plusieurs structures de votre établissement, notamment :

- le service de pneumologie, pour l'identification et le suivi des patients ;
- le service d'explorations, pour la mise à disposition d'une salle destinée au recueil des données ;
- le laboratoire central, pour la réalisation des examens biologiques nécessaires à l'étude.

Nous nous engageons à respecter strictement les règles d'éthique médicale, la confidentialité des données des patients ainsi que le règlement intérieur de votre établissement.

Dans l'attente d'une réponse favorable de votre part, nous vous prions d'agréer, Monsieur le Directeur, l'expression de notre haute considération.

Les internes :

NETI RANIA DALILA

BEROMAN NIHAL MARIANE

DR SIGA H. M. I.
Maître Assistant en
Immunologie Médicale

Appendix N°IV :

Ethics committee of Laghouat University Authorization