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Metabolic syndrome in adults: Clinical-epidemiological characteristics and current diagnostic and therapeutic alternatives

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Abstract

Background: Metabolic syndrome (MetS) is a multifactorial clinical entity characterized by a cluster of conditions—including central obesity, insulin resistance, dyslipidemia, and hypertension—that significantly increase the risk of cardiovascular disease and type 2 diabetes. Its prevalence is rising globally, with substantial implications for healthcare systems.

Objective: This review aims to describe the clinical and epidemiological characteristics of metabolic syndrome in the adult population and to analyze the currently available diagnostic criteria and therapeutic strategies.

Methods: A narrative review of the recent scientific literature was conducted, including studies published from 2015 to 2025 in databases such as PubMed, Scopus, and Web of Science. Diagnostic criteria from major health organizations (ATP III, IDF, WHO) were reviewed, as well as therapeutic approaches including lifestyle interventions, pharmacological treatments, and emerging therapies.

Results: Metabolic syndrome affects approximately 20–30% of the adult population worldwide, with variations by age, sex, ethnicity, and socioeconomic status. The most widely used diagnostic criteria include central obesity measured by waist circumference, triglyceride and HDL cholesterol levels, blood pressure, and fasting glucose. Treatment focuses primarily on weight reduction through diet and physical activity, control of individual components with medications, and management of underlying insulin resistance. New therapies targeting the gut microbiome and novel antidiabetic agents (e.g., GLP-1 receptor agonists, SGLT2 inhibitors) show promise.

Conclusion: Metabolic syndrome remains a major public health challenge. Early identification and a multidisciplinary approach to treatment are essential to reduce the risk of long-term complications. Future research should focus on personalized therapeutic strategies and prevention programs adapted to different populations.

Keywords: Metabolic syndrome; Insulin resistance; Obesity; Cardiovascular risk; Diagnosis; Treatment

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1. Introduction

Metabolic syndrome (MetS) represents a major and growing public health concern worldwide. Defined as a constellation of interrelated cardiometabolic risk factors—most notably central (abdominal) obesity, insulin resistance, dyslipidemia, and arterial hypertension—MetS significantly increases the risk of developing type 2 diabetes mellitus (T2DM), atherosclerotic cardiovascular disease (ASCVD), non-alcoholic fatty liver disease (NAFLD), and certain cancers. The concept of the metabolic syndrome has evolved over the past decades, and despite some ongoing debates over its definition and clinical utility, it remains a useful tool for identifying individuals at high risk of adverse outcomes (1, 2).

In adults, the global prevalence of metabolic syndrome ranges from 20% to over 40%, depending on the population studied and the diagnostic criteria applied. In Latin America and parts of Asia, lifestyle transitions marked by sedentary behavior, high-calorie diets, and urbanization have accelerated the incidence of MetS. In the United States, the National Health and Nutrition Examination Survey (NHANES) has documented a steadily increasing trend, particularly among older adults and minority populations (3).

Multiple diagnostic criteria have been proposed by major international organizations, including the World Health Organization (WHO), the National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP III), and the International Diabetes Federation (IDF). While they share core components, each set of criteria differs slightly in emphasis—for example, the IDF prioritizes waist circumference, whereas WHO includes measures of insulin resistance (4).

The pathophysiology of MetS is complex and multifactorial, involving genetic predisposition, chronic low-grade inflammation, endothelial dysfunction, altered adipokine signaling, and mitochondrial dysregulation. Obesity, especially visceral fat accumulation, plays a central role in the development of insulin resistance and systemic metabolic dysfunction (4).

Therapeutic strategies for managing MetS are necessarily multifaceted. Lifestyle modification remains the cornerstone of treatment, with emphasis on achieving sustained weight loss, adopting a Mediterranean or DASH-style diet, increasing physical activity, and addressing smoking and alcohol use. Pharmacologic treatment is often required for the individual components—antihypertensives, statins, metformin, and more recently, glucagon-like peptide-1 (GLP-1) receptor agonists and sodium-glucose co-transporter 2 (SGLT2) inhibitors. Bariatric surgery is a consideration in patients with morbid obesity and comorbidities (5).

The aim of this article is to present an updated synthesis of the clinical and epidemiological features of metabolic syndrome in adults, analyze the diagnostic frameworks in use, and evaluate current and emerging treatment approaches. By understanding these dimensions, clinicians and public health professionals can improve patient outcomes and contribute to the prevention of the growing burden of non-communicable diseases associated with MetS.

2. Methodology

This narrative review was conducted to examine the current clinical and epidemiological characteristics of metabolic syndrome (MetS) in adults, as well as to explore diagnostic criteria and available therapeutic strategies. The review focused on international and regional data, with particular attention to studies from the last 10 years.

2.1. Literature Search Strategy

A comprehensive literature search was performed in the following databases: PubMed/MEDLINE, Scopus, Web of Science, and Google Scholar. Keywords used included: *"metabolic syndrome"*, *"clinical features"*, *"epidemiology"*, *"diagnostic criteria"*, *"treatment"*, *"management"*, *"lifestyle intervention"*, *"cardiometabolic risk"*, and *"insulin resistance"*. Boolean operators (AND, OR) were used to refine searches.

The inclusion criteria for article selection were:

- Studies published between 2013 and 2025.
- Adult population (≥18 years old).
- Articles published in English or Spanish.
- Clinical trials, observational studies, systematic reviews, meta-analyses, and official guidelines.

Exclusion criteria included:

- Studies focused exclusively on pediatric or adolescent populations.
- Non-peer-reviewed articles or editorials.
- Studies with incomplete data or unclear methodology.

2.2. Data Extraction and Analysis

From the selected studies, data were extracted regarding:

- Epidemiological trends and prevalence by region and demographic groups.
- Risk factors and clinical manifestations.
- Comparison of diagnostic criteria from major international bodies.
- Therapeutic strategies: lifestyle interventions, pharmacologic therapy, and surgical options.
- Outcomes and effectiveness of treatment approaches.

Descriptive synthesis was used to compare diagnostic criteria, and narrative analysis was applied to assess therapeutic strategies. Emphasis was placed on evidence-based practices and consensus guidelines from leading endocrine, cardiology, and metabolic disease organizations.

This methodological approach allowed for a broad yet critical understanding of the complex and evolving landscape of metabolic syndrome in the adult population.

3. Discussion

Metabolic syndrome (MetS) is a multifactorial clinical condition representing a major public health concern worldwide. It encompasses a constellation of interconnected metabolic abnormalities—including central obesity, dyslipidemia, hypertension, and impaired glucose tolerance—that synergistically increase the risk for type 2 diabetes mellitus (T2DM), cardiovascular disease (CVD), and all-cause mortality. Over the past two decades, its prevalence has risen steadily in parallel with growing trends in obesity, sedentary lifestyles, and poor dietary patterns, particularly in industrialized and developing nations alike (6).

From a clinical standpoint, insulin resistance plays a pivotal pathophysiological role in MetS. It contributes to increased hepatic glucose production, altered lipid metabolism, and vascular dysfunction. Chronic low-grade inflammation, oxidative stress, and hormonal dysregulation (notably involving adipokines such as leptin and adiponectin) further exacerbate the disease process. Notably, many individuals with MetS may remain asymptomatic for years, highlighting the need for proactive screening and early intervention (7, 8).

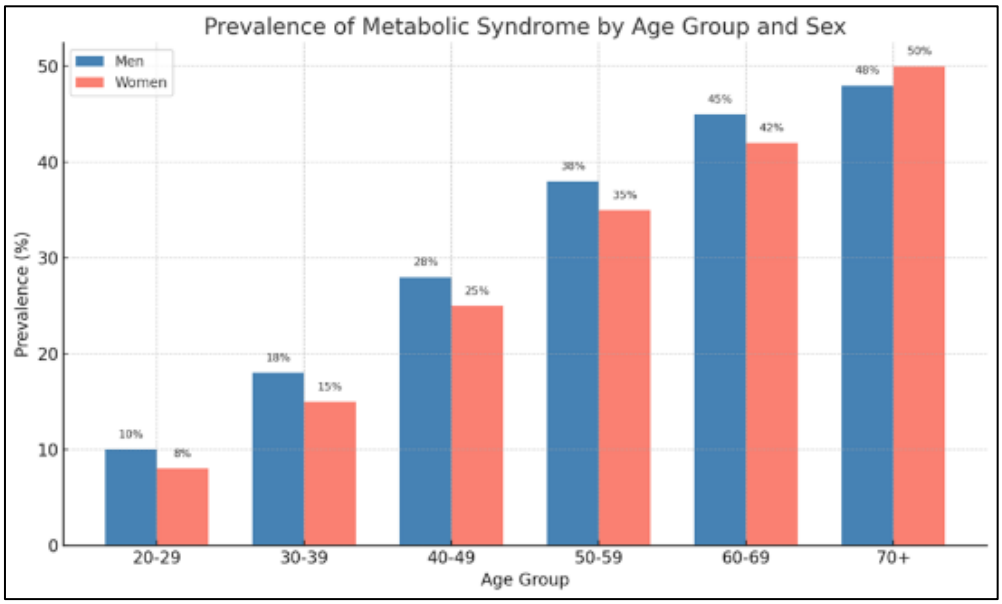

Figure 1 Prevalence of Metabolic Syndrome by Age Group and Sex

Epidemiological data reveal important demographic patterns. The syndrome is more prevalent in older populations, with risk increasing substantially after the age of 45, and is slightly more frequent among women, especially postmenopausal. Additionally, socioeconomic factors, ethnicity, and regional dietary habits influence prevalence and severity. For instance, Hispanic and South Asian populations show disproportionately higher rates of MetS even at lower BMI thresholds, emphasizing the need for ethnicity-specific diagnostic criteria (9, 10).

Here is a visual representation of the prevalence of metabolic syndrome by age and sex. This graph supports the discussion by illustrating how the risk increases with age and shows slight differences between men and women. If you need it inserted into a written article or formatted for publication, I can help with that too (11).

Despite the availability of several international definitions—such as those proposed by the World Health Organization (WHO), the National Cholesterol Education Program Adult Treatment Panel III (NCEP-ATP III), and the International Diabetes Federation (IDF) —a lack of consensus persists regarding the optimal diagnostic framework. These definitions vary in their thresholds for waist circumference, fasting glucose, and blood pressure, leading to inconsistent diagnosis and reported prevalence rates across regions. This diagnostic variability hampers the comparison of epidemiological studies and impedes the formulation of unified therapeutic guidelines (12).

Management of MetS remains challenging due to its multifactorial etiology and progression. Lifestyle interventions are the cornerstone of therapy, with weight reduction through caloric restriction and increased physical activity proving highly effective. Dietary approaches such as the Mediterranean diet and the DASH diet have demonstrated benefits in reducing abdominal fat, improving lipid profiles, and enhancing insulin sensitivity (13, 14).

Pharmacological therapy is reserved for patients who do not achieve adequate risk factor control with lifestyle changes alone. Metformin, thiazolidinediones, GLP-1 receptor agonists, and SGLT2 inhibitors are commonly used to address insulin resistance and glucose control. Statins are indicated for dyslipidemia, and ACE inhibitors or ARBs are preferred for blood pressure management in MetS patients due to their renal and cardiovascular protective effects (15, 16, 17).

Emerging therapies targeting the inflammatory pathways and gut microbiota represent a promising frontier. For example, modulation of the NLRP3 inflammasome or therapeutic targeting of pro-inflammatory cytokines (such as IL-6 and TNF-α) is under investigation. Additionally, the role of personalized medicine, including genetic and epigenetic profiling, may pave the way for tailored interventions based on individual risk stratification (18, 19, 20).

4. Conclusion

Metabolic syndrome (MetS) represents a significant and growing public health concern worldwide, strongly associated with the increasing prevalence of obesity, sedentary lifestyles, and unhealthy dietary habits. Its multifactorial nature, involving a cluster of interrelated cardiometabolic risk factors, highlights the need for early diagnosis and multifaceted interventions. Accurate diagnostic criteria such as those from the ATP III, IDF, and WHO allow for effective identification of at-risk individuals, while current therapeutic strategies focus on lifestyle modifications as the cornerstone of management. Pharmacological interventions remain crucial for patients with established cardiovascular risks or comorbidities such as type 2 diabetes and hypertension. Future approaches should emphasize preventive medicine, patient education, and the integration of emerging biomarkers and individualized care. Coordinated efforts across healthcare systems are essential to reduce the global burden of MetS and its long-term complications.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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