

Metabolic syndrome in adults: Diagnostic criteria

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Abstract

Metabolic syndrome (MS) represents a cluster of interrelated metabolic disorders that increase the risk of cardiovascular disease, type 2 diabetes and other health conditions. The growing prevalence of metabolic syndrome highlights the importance of understanding its diagnostic criteria and etiology, making the identification of diagnostic markers crucial for early detection and intervention. This article reviews the diagnostic criteria proposed by different associations, as well as its etiology and importance in clinical practice and public health. (1)

Keywords: Metabolic syndrome; Diagnostic criteria; Insulin resistance; Abdominal obesity; Blood pressure; Cholesterol; Triglycerides

1. Introduction

Metabolic syndrome has emerged as a global public health concern, affecting millions of people and contributing significantly to morbidity and mortality in adult populations. It is characterized by a set of conditions including abdominal obesity, hypertension, dyslipidemia, and insulin resistance. Early detection and implementation of diagnostic criteria for each population are essential to prevent severe complications, which makes it necessary to establish clear and precise diagnostic criteria. (2)

1.1. Metabolic Syndrome

Metabolic syndrome (MS) has become increasingly consolidated in recent decades as a clinically and epidemiologically relevant term due to its close association with type 2 diabetes (T2D), atherosclerotic cardiovascular disease (CVD), and premature mortality. It describes the coexistence in the same individual of a set of interrelated metabolic and hemodynamic abnormalities including abdominal obesity, insulin resistance, atherogenic dyslipidemia (characterized by hypertriglyceridemia and low HDL cholesterol), fasting hyperglycemia or impaired glucose metabolism, and hypertension. This clustering of factors confers a higher cardiovascular and metabolic risk than the sum of each component alone, justifying its consideration as a complex and independent clinical entity. (3)

The concept was first introduced by Reaven in 1988 under the term “syndrome X,” focused on insulin resistance as the central pathophysiological mechanism (4). Subsequently, international organizations such as the World Health Organization (WHO), the National Cholesterol Education Program (NCEP), the International Diabetes Federation (IDF), and recently, the joint statement of the AHA/NHLBI and IDF have proposed operational definitions aimed at standardizing its management in clinical practice and research. These definitions vary in the diagnostic criteria used and in the cut-off points for each variable, but all agree that central obesity and insulin resistance play a fundamental role in the pathophysiology of the syndrome (5).

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From a pathophysiological standpoint, metabolic syndrome is understood as the clinical manifestation of a complex metabolic imbalance resulting from the interaction of genetic, epigenetic, and environmental factors. The progressive increase in visceral adipose tissue triggers a state of low-grade chronic inflammation and endothelial dysfunction mediated by the secretion of adipokines and pro-inflammatory cytokines. In turn, this prolonged inflammatory state contributes to the development of insulin resistance and alterations in lipid and carbohydrate metabolism, favoring an increased risk of type 2 diabetes and atherosclerosis (6).

In terms of public health, metabolic syndrome represents a global problem. Its prevalence has risen with the obesity and sedentary lifestyle epidemic, key factors involved in the onset of this syndrome and as precursors of chronic-degenerative diseases previously mentioned, currently affecting between 20% and 40% of the adult population, depending on the diagnostic criteria applied and the geographic region analyzed. In Latin America, prevalence is particularly high and has become a challenge for healthcare systems due to the significant morbidity burden associated with it (7).

Therefore, the definition of metabolic syndrome is not limited solely to a set of laboratory values and anthropometric measurements but represents a clinical diagnosis that allows the identification of individuals at greater risk of cardiometabolic complications. Promoting early prevention strategies and guiding public health policies is essential to prevent chronic-degenerative diseases that, over time, will impact individuals' quality of life and generate higher costs associated with treatment and its consequences. Despite the existence of different definitions, there is consensus in recognizing metabolic syndrome as a useful risk stratification tool, with both clinical and epidemiological value, whose importance lies in its ability to integrate multiple dimensions of metabolic risk into a single diagnostic category.

1.2. Diagnostic Criteria

The diagnostic criteria for metabolic syndrome have been defined by several organizations, including the International Diabetes Federation (IDF), the American Heart Association (AHA), the American Diabetes Association (ADA), and the World Health Organization (WHO). Despite differences in threshold values and the inclusion of certain variables, all recognize abdominal obesity and insulin resistance as central features. A diagnosis generally requires three or more of the following: abdominal obesity, elevated triglycerides, low HDL cholesterol, elevated blood pressure, and elevated fasting glucose. (5)

The diagnostic criteria for metabolic syndrome have been defined by several organizations, among which the following stand out:

International Diabetes Federation (IDF) criteria

- Abdominal obesity: Waist circumference (WC) > 94 cm in men and > 80 cm in women.

Presence of at least two of the following factors:

- Triglycerides: ≥ 150 mg/dL (1.7 mmol/L) or treatment for dyslipidemia.
- HDL cholesterol: < 40 mg/dL (1.0 mmol/L) in men; < 50 mg/dL (1.3 mmol/L) in women.
- Blood pressure: $\geq 130/85$ mmHg or treatment for hypertension.
- Glucose: ≥ 100 mg/dL (5.6 mmol/L) or diagnosis of diabetes.

American Heart Association (AHA) and American Diabetes Association (ADA) criteria

Similar to the IDF criteria, these emphasize abdominal obesity as the main criterion and require three of the following five factors:

- Higher waist circumference.
- High triglycerides.
- Low HDL cholesterol.
- High blood pressure.
- High glucose.

World Health Organization (WHO) criteria

The WHO also considers insulin resistance as a criterion, adding the requirement of two of the following:

- Abdominal obesity.
- High triglycerides.
- Low HDL cholesterol.
- High blood pressure.
- High glucose.

Diagnostic criteria for metabolic syndrome have been defined by different organizations altogether. The American Heart Association (AHA), the American College of Cardiology (ACC), and the World Health Organization (WHO) present similar definitions that specifically include the following components:

- Abdominal obesity: Waist circumference measurement.
 - Men: > 102 cm
 - Women: > 88 cm
- High triglycerides:

≥ 150 mg/dL or specific treatment for dyslipidemia.

- Low HDL cholesterol:
 - Men: < 40 mg/dL
 - Women: < 50 mg/dL
- Arterial hypertension:

Blood pressure ≥ 130/85 mmHg or specific treatment.

- Hyperglycemia:
 - Fasting glucose ≥ 100 mg/dL or diagnosis of diabetes.
 - For diagnosis, the presence of at least three of these criteria is required. (5)

1.3. Etiology

The etiology of metabolic syndrome is multifactorial and related to genetic, environmental, and lifestyle factors. The main contributors include:

- **Obesity:** The accumulation of fat, especially in the abdominal area, is strongly associated with the development of metabolic syndrome.
- **Sedentary Lifestyle and Habits:** A sedentary lifestyle contributes to weight gain and insulin resistance.
- **Diet:** Diets high in simple sugars, saturated fats, and low in fiber are significant risk factors.
- **Genetics:** Genetic predisposition plays a role in individual susceptibility to metabolic syndrome.
- **Psychological Factors:** Chronic stress and lack of sleep may also influence the development of the syndrome by affecting hormonal regulation and eating behavior. (8)

1.4. Importance of Early Diagnosis

Early detection of metabolic syndrome allows the implementation of preventive and therapeutic strategies, including lifestyle modifications, dietary interventions, increased physical activity, and pharmacological treatments. Given the global obesity epidemic, regular evaluation of metabolic syndrome is essential. (9)

1.5. Ethnic and Cultural Considerations

Diagnostic thresholds may need adjustment according to the studied population. For example, ethnic differences in body fat distribution may require specific waist circumference cut-offs. (10)

2. Results

Table 1 Comparison of diagnostic criteria. Prepared by the authors

Criteria	WHO	NCEP-ATP III	IDF	AHA	ACC
Abdominal obesity	WC >102 cm (M), >88 cm (F) or BMI >30 kg/m ²	WC >102 cm (M), >88 cm (F)	WC >94 cm (M), >80 cm (F)	WC >102 cm (M), >88 cm (F)	WC >102 cm (M), >88 cm (F)
Triglycerides	≥150 mg/dL (1.7 mmol/L)	≥150 mg/dL (1.7 mmol/L)	≥150 mg/dL (1.7 mmol/L)	≥150 mg/dL (1.7 mmol/L)	≥150 mg/dL (1.7 mmol/L)
HDL cholesterol	<35 mg/dL (M), <39 mg/dL (F)	<40 mg/dL (M), <50 mg/dL (F)	<40 mg/dL (M), <50 mg/dL (F)	<40 mg/dL (M), <50 mg/dL (F)	<40 mg/dL (M), <50 mg/dL (F)
Blood pressure	≥140/90 mmHg or treatment	≥130/85 mmHg or treatment	≥130/85 mmHg or treatment	≥130/85 mmHg or treatment	≥130/85 mmHg or treatment
Fasting glucose	≥110 mg/dL (6.1 mmol/L) or ≥100 mg/dL (5.6 mmol/L)	≥100 mg/dL (5.6 mmol/L)	≥100 mg/dL (5.6 mmol/L)	≥100 mg/dL (5.6 mmol/L)	≥100 mg/dL (5.6 mmol/L)

3. Analysis and Discussion

Metabolic syndrome is a key risk indicator for cardiovascular diseases and type 2 diabetes. It is also a complex condition that requires precise identification of diagnostic criteria for effective management. The use of standardized diagnostic criteria improves the identification of individuals at risk and promotes interventions that may reduce the morbidity burden in the population. Ongoing research and reflection on population and cultural differences are essential to adequately adapt these criteria to diverse health needs.

According to the WHO, insulin resistance (glucose alteration) plus ≥2 abnormalities (hypertension, dyslipidemia, central obesity) are required. This is less practical in clinical settings because it requires insulin resistance measurements. Under the NCEP ATP III program, diagnosis requires ≥3 out of 5: waist circumference (Men >102 cm; Women >88 cm), triglycerides ≥150 mg/dL, low HDL cholesterol (Men <40 mg/dL; Women <50 mg/dL), blood pressure ≥130/85 mmHg, or elevated fasting glucose (threshold updated to ≥100 mg/dL). This definition is simple and widely used. In contrast, the IDF requires mandatory central obesity (waist circumference with ethnicity-specific cut-offs) plus ≥2 of the other four components. For South and Central America, it was recommended to use South Asian cut-off points (Men ≥90 cm; Women ≥80 cm) until local data become available. Meanwhile, the AHA returned to a scheme of ≥3 out of 5 components (like ATP III), without requiring central obesity, but recommending waist circumference cut-offs specific to ethnicity or country when available. This is the preferred reference for international comparison and for younger populations. (5)

4. Conclusions

Although similarities exist between the criteria of different organizations, differences in threshold values and consideration of racial and cultural factors can influence the reported prevalence and intervention strategies. Health professionals must therefore apply the most appropriate criteria for their context to achieve early and timely prevention.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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