Original Article

Analysis of the Prevalence of Metabolic Syndrome and NCEP ATP III Criteria in Older People

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Abstract

Background: Metabolic syndrome (MS) is a cluster of conditions, including hypertension, dyslipidemia, and abdominal obesity, associated with increased cardiovascular risk. In the elderly population, the prevalence of MS varies widely depending on region, lifestyle, and diagnostic criteria. Understanding the components that contribute most to MS can aid in targeted health interventions.

Objective: This study aimed to investigate the prevalence of MS and identify which components most influence its diagnosis among older adults.

Methods: This is an epidemiological, cross-sectional study conducted from January to December 2022, with people aged 60 or over, of both sexes. Data were obtained in three steps (interviews, clinical examinations, and laboratory tests). Data were entered in duplicate and analyzed using PAST software. The criteria and cutoff points adopted to diagnose MS were those proposed by NCEP ATP III.

Results: This study evaluated 127 older people, 63% female. The prevalence of MS was 40%, and the most prevalent component was arterial hypertension. Hypertriglyceridemia, waist circumference, and high blood glucose were the components of MS that contributed to 68.2% of the diagnosis of this condition.

Conclusions: The prevalence of MS was high in the population assessed. Hypertension was the most prevalent component, and hypertriglyceridemia was the component that most explained it.

Keywords: Metabolic Syndrome; Hypertriglyceridemia; Aged; Principal Component Analysis.

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Introduction

Metabolic syndrome (MS) is a set of laboratory and waist circumference changes, according to the National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP III) criteria,[1] which are associated with higher cardiovascular risk[2] and death from all causes.[3]

MS prevalence ranges from 37% to 67% in older people.[4] This range is explained by characteristics of the studied population and adopted criteria.[4-6] Factors strongly associated with MS in older people include female sex, obesity, overweight, and abnormal lipid profiles.[4]

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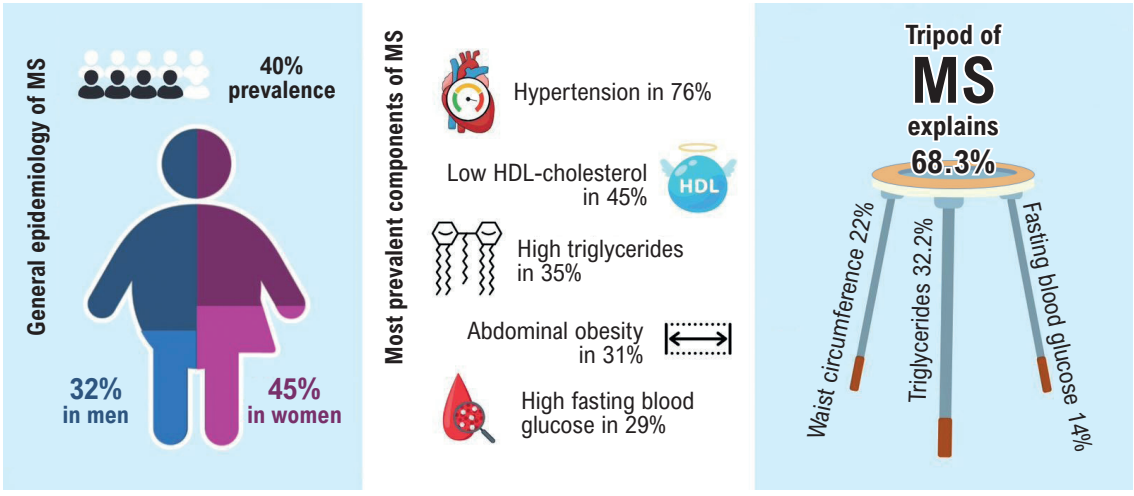
Central Illustration: Analysis of the Prevalence of Metabolic Syndrome and NCEP ATP III Criteria in Older People



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MS: metabolic syndrome; PCA: principal component analysis; HDL: high density lipoprotein.

According to the 2001 NCEP ATP III criteria,[7] MS is diagnosed when three or more of the following characteristics are present: high blood pressure, low high density lipoprotein (HDL) -cholesterol, high concentration of triglycerides, altered fasting glucose, and abdominal obesity.

MS pathophysiology involves the accumulation of visceral fat, assessed by measuring waist circumference. Elevated visceral fat causes an increase in peripheral resistance to insulin due to persistently high blood glucose, with the following consequences: hyperinsulinemia, increased serum triglyceride levels — increasing the synthesis of low density lipoprotein (LDL)-cholesterol and VLDL -cholesterol —, increased production of pro-inflammatory interleukins (IL-6), increased angiotensin (which causes an increase in blood pressure), and reduced levels of HDL-cholesterol.[7-9]

There are risk factors that communicate and contribute to the diagnosis and development of MS, which are specific to the components of MS. These factors include sedentary lifestyle, physical inactivity, inadequate eating behaviors, high sodium intake, and overweight/obesity in childhood, which increase the risk of developing arterial hypertension, dyslipidemia, obesity, and glycemic changes in adulthood.[10-16]

Few Brazilian studies have evaluated older people regarding which of five MS components best explain the emergence of this condition. Identifying these components will facilitate diagnosis and health promotion measures to reduce cardiovascular risk. Thus, this article aimed to identify the prevalence of MS and its components in older people living in a community in an urban area and to verify the components that best explain its emergence.

Material and methods

This is a cross-sectional epidemiological study conducted from January to December 2022, which enrolled people aged 60 or older living in the urban area of the municipality of Aiquara, located in the south-central region of the state of Bahia, Brazil. This work is part of a prospective cohort entitled "Health conditions and lifestyle of older people living in a small municipality: Aiquara cohort."

The study included people aged 60 or older, of both sexes, noninstitutionalized, who lived in the urban area of the municipality and excluded people with cognitive impairment (defined as Mini-Mental State Examination score < 13), those who were bedridden, and those with insufficient information to diagnose MS.

Data were obtained in three steps. In the first, during a face-to-face interview at participants' households, a bio-sociodemographic questionnaire was administered after signing an informed consent form. In the second, blood pressure and anthropometric measurements were taken; the former was taken in triplicate as per the Seventh Brazilian Guideline on Arterial Hypertension. Waist circumference (cm) was measured in duplicate at the midpoint between the iliac crest and the lowest rib, using a flexible and inelastic measuring tape, with the evaluator positioned in front of the participants. In the third step, technicians and biochemists from the Municipal Laboratory of Vitória da Conquista (LACEM, acronym in Portuguese) collected blood samples after an 8- to 12-hour fasting period. The samples were stored and processed on a Beckman Coulter® AU 680 Automated Analyzer, using the spectrophotometry method to obtain fasting blood glucose, triglycerides, and HDL-C.

MS diagnosis adopted the criteria proposed by the NCEP ATP III,[7] which consists of identifying at least three out of the following five components: presence of abdominal obesity (waist circumference) > 88 cm for women and > 102 cm for men; triglyceride levels ≥ 150 mg/dL; HDL-C concentration < 50 mg/dL for women and < 40 mg/dL for men; blood pressure values ≥ 130 mmHg for systolic blood pressure and/or ≥ 85 mmHg for diastolic blood pressure; and fasting blood glucose: ≥ 110 mg/dL.

This study complied with the ethical principles of the Declaration of Helsinki and resolution number 466/2012 of the Brazilian National Health Council. It was approved by the institutional research ethics committee under opinion number 5,703,161 (CAAE number 56017816.2.0000.0055).

Statistical analysis

The statistical analysis was conducted using principal component analysis (PCA), a technique employed to reduce the dimensionality of the dataset and identify the most relevant components contributing to the total variation of the analyzed variables. The PCA was performed using PAST software, version 2.17c, based on the correlation matrix of the following variables included in the study: blood pressure, fasting blood glucose, triglycerides, HDL-C, and waist circumference.[17] The components were ranked according to their influence on the total variation, allowing for the identification of the most significant factors for diagnosing MS.

PCA is a statistical technique that reduces the dimensionality of a dataset. This technique is based on the idea that a dataset can be represented by a smaller number of principal components, which are linear combinations of the original variables. It is often used to analyze data with many variables, as it makes it possible to identify the most important variables and reduce the complexity of the dataset.[18]

Results

A total of 311 older adults were identified as living in the urban area. After employing the inclusion and exclusion criteria, 184 older adults were excluded, totaling 127 participants in the study. Of these, 63% were female, with a mean age of 70.5 (± 8.1) years (Central Illustration).

The total prevalence of MS was 40%, 32% in men and 45% in women. Considering the NCEP ATP III criteria for the diagnosis of MS, high blood pressure was the criterion that presented the highest prevalence (76%), followed by low HDL-cholesterol (46%), high triglycerides (35%), abdominal obesity (31%), and high fasting blood glucose (29%) (Central Illustration).

The mean values of the NCEP ATP III criteria for the diagnosis of MS among older people with MS and without MS were, respectively: systolic blood pressure 151.1 mmHg and 138.2 mmHg; diastolic blood pressure 91.5 mmHg and 85.0 mmHg; triglycerides 199.7 mg/dL and 108.7 mg/dL; and fasting blood glucose 136.6 mg/dL and 102.2 mg/dL. Regarding abdominal obesity, waist circumference was 89.8 cm in men and 94.5 cm in women with MS, compared to 84.9 cm in men and 84.3 cm in women without MS. HDL-cholesterol was 34.2 mg/dL in men and 45.7 mg/dL in women with MS, compared to 45.4 mg/dL in men and 55.9 mg/dL in women without MS (Central Illustration).

Among older adults, the mean number of NCEP ATP III criteria was 2.2 (± 1.3). Among older people with MS, it was 3.5 (± 0.7), and among those without MS, it was 1.3 (± 0.7).

The PCA found that the first three components explained 68.2% of the total variation in the data, the first being explained by triglycerides corresponding to 32.2%, followed by waist circumference with 22%, and blood glucose fasting, which explained 14% of the variation (Figure 1).

Discussion

Older adults living in the urban area presented an increased prevalence of MS. Based on the NCEP ATP III criteria, the most prevalent was arterial hypertension, followed by low HDL-cholesterol, high triglycerides, central obesity, and high fasting glucose. Triglycerides, waist circumference, and fasting blood glucose explained 68.2% of MS cases.

The prevalence of MS varies depending on population, age group, sex, region, lifestyle, and diagnostic criteria used.[4-6]

Other studies that used the NCEP ATP III criteria to obtain MS prevalence found variability in the values obtained. A study conducted in Freetown, Sierra Leone, reported a 11.8% prevalence using the NCEP ATP III criteria.[1] Another study in southeastern Nigeria identified a 17.1% prevalence using the same criteria.[19] Values similar to our study were observed in studies carried out in Brazil with older people living in a community in Recife, Pernambuco (38.3%),[20] and in 378 older people living in Novo Hamburgo, Rio Grande do Sul, with a mean age of 69 (± 6) years (50%).[21] In the Brazilian population, when adopting the criteria of the First Brazilian Guideline for Diagnosis and Treatment of Metabolic Syndrome,[22] MS prevalence was 38.4%.[23] In 240 individuals aged 25 or older, living in the district of Cavunge, Bahia, Brazil, MS prevalence was 30%, and among those aged over 55 years, it was 47%.[24] The variability in MS prevalence is evident in a systematic review (22.3% to 67.9%) by Fogal et al.[25]

An upward trend of MS prevalence can be observed in the older population due to the increase in cases of type 2 diabetes mellitus and obesity due to the consumption of high-calorie foods and low fiber content, low levels of physical activity, and increased sedentary behavior.[26,27]

The prevalence of MS was higher among women. Other studies also found a higher prevalence of MS in older women.[5,28] The feminization of old age and the redistribution of body fat from the gynecoid pattern to the android or central pattern may explain this higher prevalence of MS in older women.[5,29]

In older people, the most prevalent NCEP ATP III criterion was arterial hypertension (76%), corroborating the studies by Soewondo et al. (84.1%)[30] and Souza et al. (89%).[31] In a systematic review with 21 studies, blood pressure was also the most prevalent.[25] Systemic arterial hypertension is a highly prevalent disease in older people, resulting from age-related changes, such as arterial stiffening, neurohormonal changes, renal aging, and hemodynamic changes.[32]

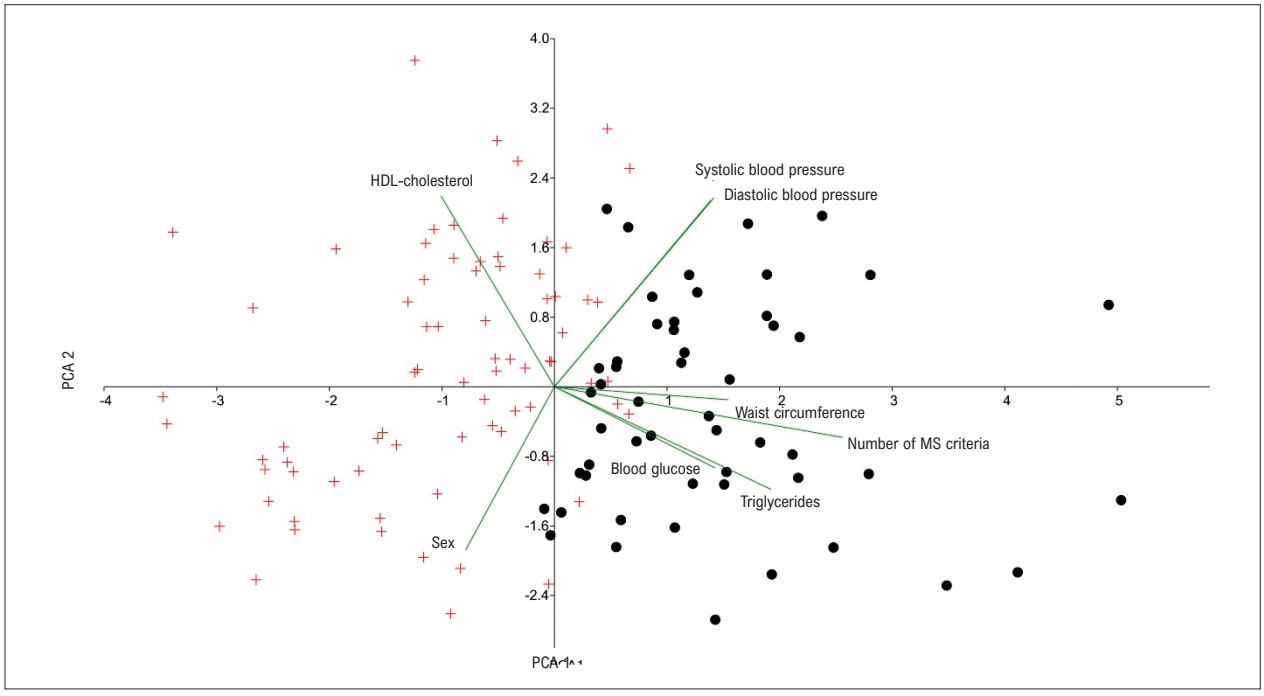

Figure 1 – *Scatterplot of PCA and biplot indicating the variation in MS criteria in older people with MS (black dots) and without MS (red crosses). MS: Metabolic syndrome; HDL: high density lipoprotein; PCA: principal component analysis.*

In the PCA, triglycerides, waist circumference, and fasting blood glucose were the criteria that most explained the diagnosis of MS in older people.

The serum triglyceride level was the criterion that most explained the diagnosis of MS (32.2%), which can be explained by its influence on the pathophysiology of the other criteria. The increase in triglyceride levels is associated with increased blood pressure through inflammatory mechanisms that cause stiffening of vessels, vasoconstriction, peripheral vascular resistance,[33] and insulin resistance[34] due to the presence of non-esterified fatty acids in the blood,[35] which cause resistance to this hormone in muscle tissues.[36] High triglyceride levels also lead to a dysfunctional increase in the number of smaller particles and a decrease in the number of larger HDL-cholesterol particles.[35]

The second criterion that most explained MS (22%) was waist circumference above the limits defined for sex. Adipocytes accumulate triglycerides inside them, which are released into the circulation according to the body's energy needs.[37] The more triglycerides accumulated, the greater their release and serum level. Therefore, waist circumference is physiologically linked to a phenotype of atherogenic lipoproteins, with elevated triglycerides and reduced HDL-cholesterol,[38-40] due to the inflammatory process and insulin resistance in adipose tissue, which stimulates lipolysis, with release of non-esterified fatty acids, which are transported to the liver, where they are re-esterified and combined into VLDL molecules,[40] with a consequent increase in the serum concentration of triglycerides.[41]

Obesity appears to be directly and linearly related to blood pressure values, being a risk factor for systemic arterial hypertension,[10] and also to the development of hyperglycemia due to the greater production of pro-inflammatory cytokines (TNF-α and IL-6) that induce hepatic and systemic resistance to the action of insulin, through the mitochondrial dysfunction of adipocytes and the increase in the release of leptin with a consequent decrease in adiponectin, which induces insulin resistance[36] and, consequently, an increase in the production of VLDL and a reduction in postprandial clearance of chylomicrons and their remnants. This favors the enrichment of LDL and HDL particles with triglycerides through the cholesteryl ester transfer protein, which are hydrolyzed in the liver with the formation of small, dense LDL molecules and reduced serum HDL-cholesterol levels.[40] Obesity is also related to a decrease in HDL-cholesterol levels while causing a reduction in the activity of lipoprotein lipases linked to blood glucose levels.[42]

The third criterion that most explained MS (14%) was hyperglycemia, resulting from peripheral resistance to insulin action. This condition is associated with the development of high blood pressure. Its pathophysiology is more complex and involves chronic inflammation and oxidative stress, increased renal sodium reabsorption, proliferation of vascular smooth muscle, and hyperactivation of the sympathetic nervous system.[43] Furthermore, insulin resistance is associated with higher triglyceride levels and a drop in HDL-cholesterol levels,[35] as previously discussed.

Hypertriglyceridemia, central obesity, and elevated glycemia with insulin resistance are, therefore, central elements in the pathophysiology of MS. One limitation of this study is the impossibility of identifying causality, as it was a cross-sectional study. However, multivariate analysis made

it possible to identify which components of MS explained its occurrence most. Therefore, based on these findings, prevention and health promotion measures can be targeted at individuals at greater risk of developing MS, fulfilling the objective of this study. New studies with a higher level of evidence and different populations are suggested to explain the occurrence of MS further.

Conclusion

The population assessed had a high prevalence of MS, which was higher among older women. Although the most prevalent component of the syndrome was arterial hypertension, the components that best explained its occurrence were increased triglycerides, waist circumference, and blood glucose.

Author Contributions

Conception and design of the research: Palmeira JPS, Sigler R, Casotti CA; acquisition of data: Palmeira JPS, Oliveira MC, Santos ES, Sigler R; analysis and interpretation of the data: Palmeira JPS, Oliveira MC, Sigler R, Nunes LA, Casotti CA; statistical analysis: Oliveira MC, Santos ES, Nunes LA, Casotti CA; writing of the manuscript: Palmeira JPS, Oliveira MC, Sigler R; critical revision of the manuscript for intellectual content: Oliveira MC, Nunes LA, Casotti CA.

Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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Study Association

This study is not associated with any thesis or dissertation work.

Ethics Approval and Consent to Participate

This study was approved by the Ethics Committee of the UESB under the protocol number 5,703,161 (CAAE No. 56017816.2.0000.0055). All the procedures in this study were in accordance with the 1975 Helsinki Declaration, updated in 2013. Informed consent was obtained from all participants included in the study.

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