BJCMR Brazilian Journal of Clinical Medicine and Review

PCAA PUBLICAÇÕES CIENTÍFICAS DE ACESSO ABERTO

*Health Review*

# Metabolic syndrome as the main risk factor associated with the development of type 2 Diabetes Mellitus and cardiovascular pathologies

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Citation: Lopes M, Souza LMO, Sousa Filho Neto GLJ, Souza CP, Rosa LMS, Marques PBF, Lima MC, Lugo RC, Sánchez RME, Cyrino RF, Dominguez LMP, Souza BPA. Metabolic syndrome as the main risk factor associated with the development of type 2 Diabetes Mellitus and cardiovascular pathologies. Brazilian Journal of Clinical Medicine and Review. 2024 Oct-Dec;02(4):23-33.

**Abstract:** The objective of this study is to gather information that corroborates that metabolic syndrome acts as the main risk factor associated with the development of type 2 diabetes mellitus and cardiovascular diseases. An integrative review, carried out between the months of August and December 2023, using the digital library Scientific Electronic Library Online (SciELO), the Virtual Health Library (VHL) and PUBMED in the databases using the Boolean operators: AND and OR. The results were obtained through management with the Rayyan 16 QCRI application and were structured in PRISMA flowcharts. With the search in the databases, 223 articles were found, of which 37 were selected for reading and, according to the objective of the present work, 23 articles were included in the research. In the studies observed, it is concluded that to prevent metabolic syndrome it is essential to adopt a healthy lifestyle, weight control, regular physical activity and frequent monitoring of blood glucose levels and regularly consult a health professional to adjust treatment. and ensure adherence to pharmacological and non-pharmacological measures.

**Keywords:** Type 2 Diabetes Mellitus; Cardiovascular diseases; Risk factors; Metabolic syndrome.

Received: 18 January 2024
Accepted: 21 February 2024
Published: 26 February 2024



## 1. Introduction

The report from the American Heart Association in partnership with the National Heart, Lung, and Blood Institute characterizes metabolic syndrome (MS) by the presence of the following components: abdominal obesity, high blood pressure, high levels of glucose and triglycerides in the blood, and low levels of HDL cholesterol in the blood [1-3]. Worldwide, the prevalence of metabolic syndrome is on the rise. In the United States (US), the incidence of this condition increased from 25.3% to 34.2% from 1988 to 2012. Furthermore, more than one-third of the adult population in the US had MS in 2012 [7]. Currently, MS affects 33% of the adult population in Brazil [4], mainly women, people with low education levels [5, 6], and the elderly [6], being considered a disease of modernity, since it is related to harmful habits typical of modern society, such as un-

healthy diets based on processed foods, sedentary lifestyles, and low consumption of fruits and vegetables, a habit that is considered protective within MS [8].

In the pathophysiology of type 2 Diabetes Mellitus, we have sustained hyperglycemia feedback-looping into tissue desensitization of insulin receptors, an inadequate response of intracellular signaling cascades, and dysfunctional glucose transporter type GLUT [9]. Metabolically speaking, this excess glucose remains circulating in the body, damaging the endothelium and tissues it passes through via glycosylation, which produces reactive oxygen species (ROS). Also, there is inhibition of lipogenesis by adipose stem cells and the enzyme lipase, a hormone responsible for lipolysis, leading to the saturation of existing adipose cells, increasing the concentration of inflammatory cytokines, producing more ROS due to increased metabolism of this tissue without adequate blood supply, and hypertriglyceridemia due to hepatic conversion of fatty acids, due to low peripheral uptake of them [10].

Throughout the course of the disease, a progressive and chronic proinflammatory state is maintained, mainly through TNF-, resistin, IL-1, and IL-6, which affect not only the individual's metabolic pathways but also aggregate renal, ophthalmological, hepatic, cardiovascular, muscular, neurological, and vascular changes [9, 11]. Microscopically, these neurovascular alterations are noticed through demyelination, culminating in peripheral neuropathies with loss of sensitivity, alteration of autonomic innervation of blood vessels, affecting their responsiveness [10, 12].

Finally, there is alteration of tissue perfusion by mechanisms of endothelial injury and hypercoagulability by the extrinsic pathway of the coagulation cascade, that is, components of Virchow's Triad, which are important factors in the pathophysiology of cardiovascular diseases with or without ischemic component, for example: systemic arterial hypertension (SAH), acute myocardial infarction (AMI), stroke (AVC), chronic arterial disease (CAD), atherosclerosis, thromboembolism, and deep vein thrombosis (DVT) [13]. Regarding the prevention of metabolic syndrome, hygienic dietary measures constitute fundamental pillars. The consumption of alcoholic and distilled beverages and smoking increase the risk of metabolic syndrome [14]. On the other hand, regular physical activity, weight control, and a balanced diet act in preventing and assisting in the treatment of MS [15].

In general, metabolic syndrome is associated as the main risk factor for the development of type 2 diabetes mellitus [16] and cardiovascular pathologies, which are physiopathologically interrelated, perpetuating endocrine-metabolic dysfunctions, decreasing the effectiveness of treatment for present diseases and, consequently, worsening the prognosis of individuals [17,18,19]. Therefore, the objective of this study is to gather information that corroborates that metabolic syndrome acts as the main risk factor associated with the development of type 2 diabetes mellitus and cardiovascular diseases.

## 2. Material and methods

This study is characterized as an integrative review, which allows the search, evaluation, and synthesis of evidence about a given phenomenon [1]. For the construction of this study, the choice of the theme and the definition of the guiding question were first carried out: "*Why is metabolic syndrome the main risk factor associated with the development of type 2 diabetes mellitus and cardiovascular pathologies?*".

We sought to answer the main guiding question based on the PICO strategy (acronym for Patient, Intervention, Comparison and Outcome), i.e., in view of this, the PEAK corresponds to, respectively, P= Patients with Metabolic Syndrome; I= Risk factors for the development of type 2 DM and cardiovascular diseases; CO= Metabolic Syndrome. The inclusion criteria established: primary research article published in the Portuguese language, English or Spanish, with a time limit in the last 13 years (2010-2023). Letters to the editor, expert opinions, reviews, books, book chapters, experience reports, case studies, theoretical reflections, theses, dissertations, monographs, and abstracts published in conference proceedings were excluded.

The searches were carried out between August and December 2023. In this step, the terms in Portuguese were chosen through the Health Sciences Descriptors (DeCs) and the terms in English through the Medical Subject Heading (MeSH). The locations where the search would take place were established, as well as the inclusion and exclusion criteria for the studies. The articles were selected by online access using the Scientific Electronic Library Online (SciELO), the Virtual Health Library (VHL), in addition to the following health database: PUBMED, available on the portal of Journals of the Coordination for the Improvement of Higher Education Personnel (CAPES) obtained through the Federated Academic Community (CAFe).

The following Boolean operators were used to search the databases: AND and OR, to improve the search in the databases. Therefore, we will use the following descriptors in Health Science (DeCS) and Medical Subject Headings (MESH): Type 2 Diabetes Mellitus OR Cardiovascular diseases AND Metabolic syndrome OR Risk factors, which were performed in different combinations. Rayyan16 QCRI (http://rayyan.qcri.org/) was used to manage the results, to exclude duplicate articles, identify those related to the guiding question, and apply the exclusion and inclusion criteria. The studies were identified in the sources of information selected by two independent researchers, previously trained to evaluate titles and abstracts, through a free single-version web review program, called the Rayyan Qatar Computing Research Institute (Rayyan QCRI) [2]. For a better understanding and transparency in the selection method, it was decided to present the flowchart of scientific articles through the guide to the Main Items for Reporting Systematic Reviews and Meta-analyses (PRISMA).

## 3. Results and discussion

With the search in the databases, 223 articles were found, of these 37 articles were selected for reading and, according to the objective of this work, 23 articles were included in the research: four from the Virtual Health Library, 14 articles from PubMed, 5 articles from SciELO as represented in figure 1 and table 1.

**Figure 1.** Schematic representation of synthesis and analysis of results.

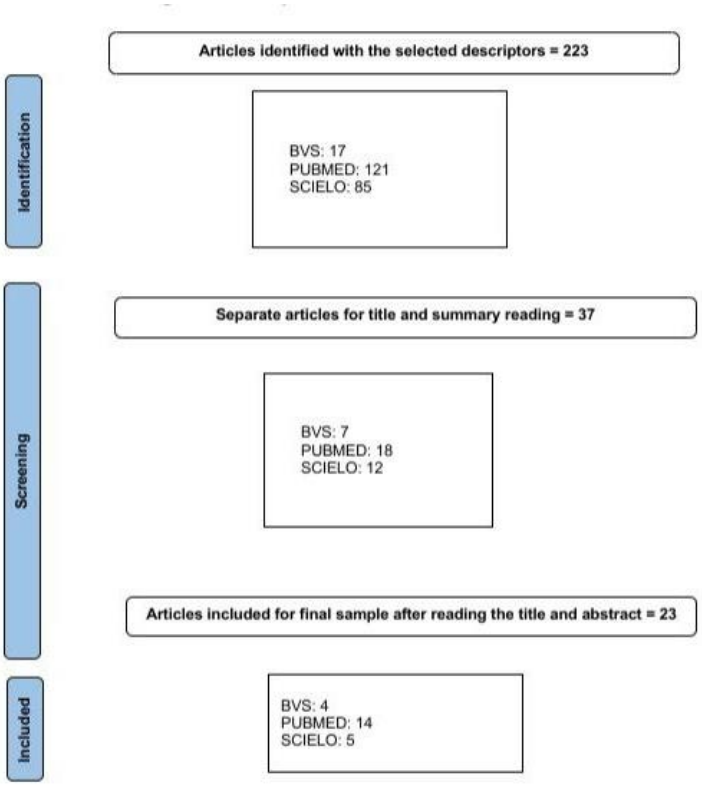

**Table 1.** Characteristics of the selected studies, regarding author, year of publication, objectives, approach and main results.

| Title | Goal | Main results |
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| [1] | To determine the prevalence of metabolic syndrome in Brazil | High prevalence of MS in the healthy Brazilian adult population, when compared to several countries and with a worldwide estimate. In addition, the high prevalence remained when we subdivided the data according to different criteria, such as diagnosis, gender, age, and geographic area of the subjects studied, which suggests urgent attention from both a clinical and public health point of view. |
| [2] | The aim of this study was to analyze the specific role of exercise and/or physical activity in changes in body composition, cardiovascular system, biochemical and hormonal plasma levels, and reproductive function of women with PCOS. | The regular practice of physical exercise in women with PCOS has shown relevant therapeutic importance, since evidence indicates positive results of this modality in aspects related to body composition, metabolic, cardiovascular and hormonal parameters, in addition to reproductive function. However, knowledge is still incipient regarding the dose-response relationship to obtain these benefits, as well as regarding the type, intensity, duration, frequency. The use of resistance exercises is still nebulous in this sense, with a lack of studies emphasizing this specific modality of practice. In our research group, a study specifically designed for this purpose is underway, so that, in the near future, it is intended to have subsidies to guide clinical decisions in this regard, based on scientific evidence that is more appropriate to our epidemiological profile. |
| [3] | To estimate the prevalence of Metabolic Syndrome (MS) and its components in the Brazilian population according to sociodemographic factors. | The prevalence of MS and its components was estimated with 95% confidence intervals, and the crude and adjusted prevalence ratio (PR) with Poisson regression. The prevalence ratio of MS was 38.4%. High waist circumference (WC) (65.5%) and low HDL-cholesterol (49.4%) were the most prevalent components, even in younger people. MS and its components were more frequent among women (41.8%), individuals with low schooling (47.5%) and elderly (66.1%). In adjusted analysis, female gender (PR = 1.16; 95% CI 1.08-1.24), elderly (PR = 3.69; 95% CI 3.26-4.17) and low schooling (PR = 1.32; 95% CI 1.17-1.49) were associated with MS. MS was prevalent in the Brazilian population, especially among women, individuals with low schooling, and the elderly. High WC and low HDL cholesterol were the most prevalent components, with a high prevalence in young adults. |
| [4] | To identify FVL consumption and its relationship with MS and its components in an adult population sample. | The results of the present study showed that mainly fruits presented a protective factor against some components of MS, corroborating a recent study conducted with Brazilian patients with type 2 Diabetes Mellitus (DM) that demonstrated that the consumption of foods rich in soluble fiber, represented by whole grains and fruits, was a protective factor for the presence of MS. |
| [5] | To clarify the prevalence and risk factors of diabetic dyslipidemia | Diabetes mellitus is a disease with a high global prevalence, associated with cardiovascular mortality and microvascular complications, which confer a chronic character to this pathology. In type II diabetes, the atherosclerotic process begins even before diagnosis, hence the importance of recognizing the risk factors involved in the pathophysiology of vascular disease in this population. |

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| | | Dyslipidemia in diabetics is characterized by small, dense, triglyceride-rich, LDL-rich lipoproteins and very atherogenic, and low HDL-c. Statins are the drugs of choice to treat dyslipidemia and significantly reduce cardiovascular risk in these patients. Although intensive glycemic control did not reduce cardiovascular events in randomized studies, some hypoglycemic agents had a favorable effect on the lipid profile, with a reduction in future events. |
| [6] | The aim of this study was to analyze the pathophysiology, complications and treatment of the pathology | The most important aspects of the physiology, pathophysiology, complications and therapeutics of this pathology were identified. Insulin resistance (IR) is a central metabolic condition in the etiopathogenesis of this pathology. Classically, it is possible to recognize both the loss of peripheral insulin action by different tissues and defects in insulin secretion that lead to constant hyperglycemic states associated with acute and chronic complications characterized by causing dysfunction and failure in different organs. It is known that an important part of the results in the management of this pathology is achieved with lifestyle changes ranging from dietary modifications to changes in the pattern of physical activity with loss of body weight. However, there is also a wide range of pharmacological therapies aimed at controlling hyperglycemic states in the event of failure of non-pharmacological therapy. Within this same context, there are several therapeutic goals and objectives in the treatment of type 2 diabetics, however, all converge in the metabolic control of hyperglycemic states and in the prevention of their complications. |
| [7] | The aim of this study was to provide a detailed and up-to-date review of diabetic neuropathy, focusing on its classification, diagnostic workup, and treatment | Early and correct diagnosis enables appropriate treatment, avoiding the progression of neuropathy and serious complications. For this, it is necessary to obtain a careful clinical history, in addition to a thorough neurological examination and complementary tests, in order to identify signs of nerve fiber involvement. Its treatment depends on adequate glycemic control and, when present, treatment of neuropathic pain. |
| [8] | To identify the scientific productions about the risk assessment strategies for venous thromboembolism, for application by the nurse in the care of cancer patients | Although there is scientific literature on risk assessment strategies for venous thromboembolism, the diversity of risk prediction models and biomarkers may hinder the choice of nurses in the care of cancer patients. |
| [9] | To identify risk factors potentially associated with glucose control and Metabolic Syndrome (MS) of patients with T2DM from a Health Services Provider Institution (IPS) | More than 90% of individuals were older than 49 years; 50.6% hombres; 46.6% had glycosylated hemoglobin (HbA1c) levels greater than 7%; 64.5% SM teni. Individuals with hyperglycemia were 3.1 times more likely to have inadequate glucose control (95% CI: 2.28-4.25, $p<0.05$); those with hypothyroidism were 1.2 times more likely to develop MS (95% CI: 1.01-1.35; $p<0.05$) and those with heart disease were 1.3 times more likely to develop MS. |

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| | in Villavicencio. | |
| [10] | To evaluate the metabolic syndrome and cardiovascular risk of elderly hypertensive patients treated in primary care. | 64.9% of the hypertensive elderly were obese. Metabolic syndrome was observed in 70.8%. It was observed that 27.2% had low, 46.8% moderate and 26.0% high cardiovascular risk, with female gender and advanced age negatively influencing the risk. Older adults with metabolic syndrome were 7.19 times more likely to have high cardiovascular risk. |
| [11] | To compare the metabolic, anthropometric, blood pressure and muscle strength parameters of elderly women with and without metabolic syndrome. | When compared to elderly women without metabolic syndrome, those with metabolic syndrome had higher levels of body mass (72.2±13.5 versus 63.4±14.6kg, p=0.03), body mass index (31.0±5.0 versus 27.2±5.3kg/m², p=0.007), fat mass (30.9±9.9 versus 24.4±8.5kg, p=0.01), systolic blood pressure (125.1±8.2 versus 119.3±8.7mmHg, p=0.01), diastolic blood pressure (75.5±6.9 versus 71.4±6.7mmHg, p=0.03), mean arterial pressure (92.5±6.2 versus 87.1±6.7mmHg, p=0.004), blood glucose(103,8±19,1). |
| [12] | To evaluate the influence of metabolic syndrome on the effectiveness of antihypertensive treatment and to compare it using the definitions of the National Cholesterol Education Program Adult Treatment Panel III (NCEP-ATP III) (2001 and 2004), the International Diabetes Federation (IDF) and the American Heart Association/National Heart, Lung and Blood Institute (AHA-NHLBI). | Among the 16,856 individuals evaluated, 8925 hypertensive patients were identified. Only 35.8% of them had controlled hypertension. The risk of poor blood pressure control increased with age, waist circumference, serum triglyceride and HDL-cholesterol levels. Among the treatable risk factors, metabolic syndrome as defined by the 2001 NCEP-ATP III diagnostic criteria was the strongest independent predictor of uncontrolled hypertension (odds ratio: 1.23; 95% CI: 1,08-1,41; P=0,002). In contrast, the IDF or AHA-NHLBI definitions of metabolic syndrome failed to identify patients at risk for poor blood pressure control. |
| [13] | To assess how metabolic disorders affect antihypertensive therapy. | The presence of metabolic disturbance factors ≥3 was associated with higher risks of poor BP control. The associations of metabolic factors and uncontrolled hypertension were stronger for the standard and modified ATP III criteria, compared to the IDF and JIS criteria. Metabolic factors were associated with less effective antihypertensive therapy, and all definitions of metabolic syndrome helped identify patients at increased risk of uncontrolled hypertension. |
| [14] | To evaluate the impact of physical activity (PA) on metabolic syndrome | The respective odds ratios (95% confidence intervals) for men and women were 0.58 (0.43-0.79) and 0.67 (0.52-0.86), 0.52 (0.34-0.79) and 0.52 (0.33-0.83), and 0.79 (0.63-0.99) and 0.71 (0.57-0.89). Similar results were observed with regular activity, with a frequency of >3 sessions per week. Both regular and weekend warrior AF patterns showed a 10-60% reduction in abnormal triglycerides, glucose, and blood pressure in both sexes; circumference of the abnormal waist only in men; and abnormal high-density lipoprotein only in women. Our ob- |

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| | | served cross-sectional relationships reflect that >150 min/week of moderate PA or 75 min/week of vigorous PA are necessary to prevent MS and its component diseases, even in a short-term intermittent PA pattern. |
| [15] | To examine the association between physical activity (PA), body composition, and metabolic disorders in a population of women classified according to menopausal status. | In all participants, peri- and postmenopausal women, PA was significantly and inversely associated with BMI, weight, body fat percentage, WC, WC and number of MS components ($p < 0.01$), and with fasting glucose, TC, TG and LDL-C ($p < 0.05$). The frequencies of metabolic disorders, obesity, abdominal obesity, type 2 diabetes, dyslipidemia, and MS were significantly lower in moderate and severe PA levels ($p < 0.05$), also in all participants. In middle-aged women, particularly those in perimenopause, FA at moderate and severe levels is associated with more favorable body composition and less frequent metabolic disorders. However, in this particular study, FA does not appear to be associated with blood pressure and HDL-C concentrations. |
| [16] | To compare the body adiposity indices (BAIs) and evaluate their various cut-off values for the prediction of MS in university students | The overall prevalence of MS was 5.9%, higher in men than in women. The most prevalent components were low HDL-C, high triglycerides, CC and BP. The analysis of the receiver operating characteristic curves showed that BAI, BAI-w and BAI-p can be useful tools to predict MS in this population. |
| [17] | To evaluate the effect of mineral water in relation to metabolic syndrome | Mineral waters were tested in several protocols regarding the type and composition of the water, amount consumed, diet, and type and duration of the study. Human and animal studies have been conducted on populations with different sizes and characteristics. Separate sets of five studies showed beneficial effects on BP, total triglycerides, HDL-cholesterol and glucose. Modulation of CC has not been reported. Active minerals/elements and ions/molecules present in mineral waters (and their pH) are crucial to counterbalance their inadequate intake and body state, as well as the metabolic dysfunction and diet-induced acid load increase seen in MetSyn. The characteristics of the study and the molecular/physiological mechanisms that could explain the different effects observed are discussed. |
| [18] | To compare the effects of consuming FO and sunflower seed oil (SO) on lipid peroxidation and other symptoms of SMin. | There was no significant difference between the 2 groups regarding blood lipid levels and fasting glucose at the end of the study. However, significant reductions in total cholesterol, low-density lipoprotein (5.6% in FO and 10.8% in SO), and triglyceride levels were observed within each group after treatment with FO and OS (P<.05). However, intergroup changes were significant (<0.05) for systolic BP (mean [±standard deviation {SD}] was -14.05 0 ± 22.41 in the FO group [P = .004] and 0.92 ± 8.70 in the OS group [P = .594]) and diastolic (mean changes [±SD] were -4.26 ± 7.44 in the FO group [P = .007] and 1.30 ± 6.91 in the OS group [P = .344]), but marginally significant (P = .053) for malondialdehyde level (mean changes [±SD] were -1.29 ± 1.48 in the FO group [P < .001] and -0.52 ± 1.34 in the OS group [P = .52]). A significant decrease in weight was also found in both groups. However, waist circumference decreased significantly |

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| | | only in the FO group at the end of the study (P <.05). |
| [19] | Prevalence of Metabolic Syndrome (MS) and its components in the Brazilian population according to sociodemographic factors | The prevalence of MS was 38.4%. High waist circumference (WC) (65.5%) and low HDL cholesterol (49.4%) were the most prevalent components, including in young people. The occurrence of MS was higher among women (41.8%), individuals with low schooling (47.5%) and the elderly (66.1%). In the adjusted analysis, female gender (PR = 1.16; 95%CI 1.08-1.24), advanced age (PR = 3.69; 95%CI 3.26-4.17) and low schooling (PR = 1.32; 95%CI 1.17-1.49) were associated with the occurrence of MS.MS was very prevalent in the Brazilian population, especially among women, individuals with low schooling, and the elderly. High WC and low HDL cholesterol were the most frequent components, with the aggravating factor of high prevalence in young adults. |
| [20] | To investigate the role of ABs in the pathophysiology of DM2, highlighting the possibilities in the development of therapeutic procedures directed to PC as an optional route in the treatment of DM2. | Studies report the involvement of ABs in the pathophysiology of DM2. BAs act as a ligand for the nuclear farnesoid X receptor, regulating glucose metabolism, lipid metabolism, and cellular energy production. In addition, ABs modulate the production, elimination, and mobilization of ABs through the farnesoid X receptor. BAs also act as a signaling pathway through the Takeda G protein-coupled receptor 5, further contributing to metabolic regulation. These findings suggest that targeting AB. |
| [21] | To determine the prevalence of metabolic syndrome (MS) and its components in Brazilian adolescents. | We identified 15 studies, including 43,227 adolescents. The prevalence of MS (95% confidence interval [95%CI]) was 2.9% (2.65–3.18) and 2.4% (1.90–2.90) (p<0.001) in men and women, respectively, using International Diabetes Federation (IDF) criteria. There was a significant difference in the prevalence of MS between the Brazilian regions (Q=24.7; p<0.001). The lowest prevalence of MS (95%CI) was determined for the Northern Region of Brazil, 1.8% (1.52–2.13), and the highest for the Northeast Region of Brazil. |
| [22] | To investigate the association between MS and its components and MACE after percutaneous coronary intervention (PCI) in patients with acute coronary syndrome (ACS). | The mean age of patients with MS was slightly higher than that of patients without MS (63.0 ± 10.6 vs. 62.1 ± 11.5, P < 0.001). Among the MS group, 60.1% were male, while the corresponding percentage in the group without MS was 90.5% (P < 0.001). Patients with MS had a significantly higher prevalence of history of CPI, CABG, STROKE, STEMI, scasest, and family history of CAD.The MS group demonstrated higher levels of total cholesterol, TG, GPJ, and creatinine. In addition, patients with MS had higher rates for aspirin, P2Y12 inhibitors, statins, ACEI/ARBs, beta-blockers, and nitrates (all P < 0.05). Presentation with STEMI and NSTEMI was lower among MS patients (NSTEMI: 17.8% vs. 18.9%, STEMI: 33.4% vs. 39.2%), while UA was more frequently observed in these patients (48.8% vs. 41.9%). The degree of pre-procedure coronary vessel stenosis was slightly lower among MS patients (91.4% ± 8.9% vs. 92.1% ± 9.0%, P < 0.001). Although patients without MS had relatively lower pre-procedure flow of Thrombolysis in Myocardial Infarction (TIMI) (P < 0.001), they had a higher prevalence of single-vessel occlusion compared to the MS group (38.9% vs. 34.5%, P < 0.001). The proportion of |

complete revascularization of the target lesion was comparable between the MS and non-MS groups (MS: 95.0%, non-MS: 94.4%, P = 0.165).

It is understood that the diseases that make up the metabolic syndrome (MS) are multifactorial, chronic, insidious in their initial stages, progressive and, when one is established in the individual, it becomes a risk factor for the emergence of the others. This character gives this syndrome a high morbidity and mortality rate, since cardiovascular causes are considered, today, the main cause of deaths in the world. Microscopically, the imbalance primarily involves failure of cellular signaling associated with overload and deviations in carbohydrate and lipid metabolism; Therefore, when this organic stress is perpetuated in various tissues, the body begins to present failures in the secretion of hormones, as well as the production and support of pro-inflammatory mechanisms against regulators; which culminate in changes in body composition.

Clinically, this change translates into the form of diabetes - altered secretion and low sensitivity to insulin, with tissue oxidative stress through glycation; dyslipidemia- metabolic shift of excess glucose to the fatty acid pathway with formation of triglycerides by the liver, dysfunction of adiponectins, increase in inflammatory adipokines, desensitization to leptin and greater concentration of cholesterol by the liver in the form of LDL due to overload of adipose tissue. These initial changes alter the anorectic pathways and inhibit the negative feedback of the hunger pathways, increasing calorie consumption, maintaining the metabolic errors described above and establishing obesity in these individuals. With hyperglycemia, lipid accumulation, pro-inflammatory state and low sensitivity to the counter-balancing responses of this cycle; we have the process of tissue damage and development of pathologies primarily in organic systems more sensitive to these variations such as: central nervous, renal, cardiac and vascular systems.

Even though there are strong known genetic-environmental risk factors, the behavioral component plays a strong role in the incidence of these diseases, being a possible target for intervention and containment, with low cost and high effectiveness. These modifiable factors such as education, balanced diet, cessation of smoking and alcoholism, physical activity, restful sleep, stress containment measures, timely screening, adequate treatment, care and rehabilitation segment; These are some basic health promotion and primary, secondary and tertiary prevention measures that, if well executed, help to break the MS cycle, prevent the progression of multimorbidities and, consequently, reduce their impact in the health-social-economic sphere.

Based on the study on Prevalence of metabolic syndrome in Brazilian adults in the last 10 years it had a large search in electronic databases and identified 1,598 records. Of this total, 26 studies were eligible for inclusion in the final analysis. The overall clustered prevalence among the general population of Brazil was 33%, with high heterogeneity observed. By sex, the prevalences were 26% in males and 38% in females. According to the criteria used to define MS, the prevalences were 31% in the NCEP ATP III, 25% in the JIS, 37% in the IDF/NHLBI/AHA/WHF/IAS/IASO criteria and 33% in the IDF criteria. The prevalence in the different habitats was 34% in the urban area, 15% in the rural area, 28% in the quilombola area and 37% in the indigenous area. In the different regions, it was 37% in the South, 30% in the Southeast, 38% in the North, 31% in the Northeast and 39% in the Midwest.

## 4. Conclusion

It is clear that MS occurs when there is the presence of certain components, such as abdominal obesity, high blood pressure, high levels of glucose and triglycerides in the blood and low levels of HDL cholesterol in the blood. They contribute to increased cardiovascular risk and insulin resistance. All of this makes MS the main risk factor for type 2 diabetes mellitus and cardiovascular diseases. MS not only affects adults, but also children and adolescents, which has had a very considerable incidence. Among adults,

the most prevalent classes are women, people with low education and the elderly, as they have more unhealthy lifestyle habits.

Thus, the main risk factor associated with type 2 diabetes mellitus and cardiovascular diseases is MS, since these pathologies are pathophysiologically interrelated, which causes endocrine-metabolic dysfunctions to occur, worsening the effectiveness of the treatment of these diseases and the prognosis of patients. Therefore, to prevent this disease, it is necessary to carry out primary prevention in the general population, carrying out campaigns and lectures in favor of a healthy lifestyle through a balanced diet rich in vegetables, fiber and lean proteins, and not excessive salt consumption, not drinking alcoholic beverages, not smoking, doing physical activity according to the person's age, sex, and characteristics. However, this lifestyle is important to establish from childhood and adolescence due to the increase in obesity at a young age.

It is essential to reinforce the work of the multidisciplinary team made up of nutritionists, physical education professionals, doctors, among others, to obtain benefits for people's health. However, government participation is extremely important, through public policies, to encourage the population to take care of their health. It is also important to regularly consult a healthcare professional to prevent illnesses and control existing pathologies.

**Funding:** None.

**Research Ethics Committee Approval:** None.

**Acknowledgments:** None.

**Conflicts of Interest:** The authors declare no conflict of interest.

**Supplementary Materials:** None.

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