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Original Research

Evaluation of anthropometric and cardiometabolic changes and their implications on cardiovascular risk in adults with obesity and metabolic syndrome at a university hospital in the amazon region

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Abstract

Background: To analyze the impact of obesity and MS on cardiovascular risk and cardiac conditions with obesity with and without MS. **Methods:** The study conducted was a descriptive retrospective cross-sectional study, carried out with obese patients under care at the Cardiology Outpatient Clinic of João Barros Barreto University Hospital in Belém/PA. Inclusion criteria included individuals over 18 years old, diagnosed with obesity with or without Metabolic Syndrome, and who had updated laboratory, electrocardiographic, and echocardiographic exams available. The study was conducted in 2023 and is part of the project approved under opinion No. 69722423.30000.0018. The Chi-square test was used to describe the relationship between variables, with statistically significant values considered as hypothesis tests with $p < 0.05$. **Results:** The study evaluated 100 individuals with obesity, of which 60 had MS, with a mean age of 54 years and a prevalence of females. There was an association between the presence of high Framingham Risk Score (FRS) and changes in BMI, waist circumference, systolic blood pressure (SBP), HDL, triglycerides, total cholesterol, and glucose indices for both groups. There was an association between the presence of MS and high FRS in women. **Conclusion:** Thus, in both groups, there was a occurrence of high FRS, especially in obese women. Obese individuals without MS have a similar risk, requiring appropriate attention to the cardiac health of such individuals.

Keywords: metabolic syndrome; obesity; risk factors; cardiovascular diseases

INTRODUCTION

Behavioral changes over the past decades, especially in terms of eating habits, directly contribute to the rise in individuals with obesity. In the year 2022, there were approximately 6.7 million obese individuals in the Brazilian population, making it the most prevalent endocrine disorder in the country.[1] Thus, excess body fat is associated with the development of metabolic disorders, other endocrine disorders with metabolic syndrome, which has a significant impact on cardiovascular health.[1,2]

As per the definition by the National Cholesterol Education Program's Adult Treatment Panel III, Metabolic Syndrome (MS) can be diagnosed based on criteria[1], where an individual must have at least three of these components: elevated waist circumference (>88 cm for women and >102 cm for men), elevated serum triglycerides (≥150 mg/dL), reduced serum HDL-cholesterol levels (<40 mg/dL for men and <50 mg/dL for women), high blood pressure (≥130/85 mmHg), and elevated fasting glucose (≥110 mg/dL). All these variables are associated with an increased risk of various heart conditions[2]. Currently, six disorders are recognized as components of MS: abdominal obesity, atherogenic dyslipidemia, high blood pressure, insulin resistance, pro-inflammatory state, and pro-thrombotic state.[3]

In this context, obesity, another factor related to the development of Cardiovascular Diseases (CVD), is a chronic disease characterized by abnormal or excessive fat accumulation in the body. Additionally, it increases the risk of diabetes mellitus, musculoskeletal disorders, and certain neoplasms.[1,4] The diagnosis of obesity is defined by dividing weight in kilograms by the square of height in meters (kg/m²), with a BMI greater than or equal to 30 kg/m².[5] Thus, it becomes a factor of very high prevalence for the development of cardiac alterations. While studies demonstrate that the components of MS individually increase the risk of CVD development, a condition known as metabolically healthy obesity (ObMS) is suggested. This is characterized by a subgroup of obese individuals without cardiometabolic alterations.[4,5]

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Moreover, it is suggested that ObMS has been associated with the emergence of cardiovascular pathologies, obstructive sleep apnea, renal, biliary, and orthopedic diseases, the onset of neoplasms, and the prevalence of metabolic disorders, all stemming from the detrimental effects of excess adipose tissue in the body. Studies have been conducted to clarify the cardiovascular repercussions of obesity without MS; however, the results are not as conclusive as the influence of ObMS on cardiovascular health. Therefore, the aim of this study was to evaluate the impact of obesity and metabolic syndrome on cardiovascular risk and cardiac involvement, in individuals with obesity, with and without MS.

METHODS

The present study is part of a larger project titled „Cardiovascular Risk and Cardiac Involvement in Patients with Obesity and Metabolic Syndrome in a University Hospital in the Amazon Region". The study was approved by the Research Ethics Committee of the Federal University of Pará (CEP/UFPA) in Brazil under reference number CAAE 69722423.3.0000.0018. A descriptive retrospective cross-sectional study was conducted with obese patients under follow-up at the Cardiology Outpatient Clinic of João Barros Barreto University Hospital (HUJBB) in the city of Belém, PA, Brazil. Individuals aged 18 years and older with a diagnosis of obesity with or without metabolic syndrome and who had updated laboratory, electrocardiographic, and echocardiographic exams were included in the study.

Out of the 180 patients selected for the study, only 100 were eligible for the research. Patients under the age of 18 or over 75, individuals overweight without a diagnosis of metabolic syndrome, or those lacking laboratory, electrocardiographic, and echocardiographic exams were excluded. The sample was selected for convenience. Data were collected regarding patient demographics (gender and age), laboratory tests (fasting glucose, total cholesterol - TC, HDL, LDL, and triglycerides), blood pressure measurement (BP), anthropometry (weight, height, body mass index - BMI, and waist circumference - WC), and up-to-date electrocardiographic and echocardiographic exams. All information was obtained from the patient records selected for the study, and the Informed Consent Form (ICF) was used to obtain permission for using clinical data from outpatient evaluations and medical records for research purposes.

The diagnosis of obesity was adopted according to the 4th edition of the Brazilian Association for the Study of Obesity and Metabolic Syndrome, considering an adult as obese when their BMI is greater than or equal to 30 kg/m².[2] For the diagnosis of Metabolic Syndrome (MS), the National Cholesterol Education Program-Adult Treatment Panel III (NCEP-ATP III) criteria were adopted, as they align better with the clinical routine of Brazilian health institutions. This criteria involves identifying five variables: abdominal obesity via waist circumference (WC), triglycerides, HDL cholesterol, systolic blood pressure (SBP), and fasting glucose.[2]

For the calculation of Cardiovascular Risk (CVR), the Framingham risk score (FRS) was used. In this score, each variable has specific positive or negative scores based on value ranges. The total score takes into account variables such as gender, age, smoking, diabetes mellitus, HDL, TC, SBP, and diastolic blood pressure (DBP). The resulting score corresponds to a percentage probability of developing coronary atherosclerotic disease (CAD) over the next 10 years. Individuals are classified into the following categories: low risk with a probability <10% of cardiovascular events in 10 years; medium risk between 10% and 20%; and high risk >20%.

For the analysis of cardiovascular risk and cardiac involvement data in patients with Metabolic Syndrome, data tabulation was performed in Microsoft Office Excel 2016 spreadsheets. These were used to construct tables and graphs, aiding in data visualization and interpretation. Data were described in terms of absolute and relative frequency. After data tabulation, the statistical program BioEstat 5.4 was used for formulating statistical tests, showing frequencies of cardiovascular risk and cardiac complications in patients with MS. Continuous variables were described as mean ± standard deviation. The comparison of these variables between groups was done using the Student's t-test for independent samples. For variables that showed significant differences ($p \leq 0.05$), calculating the Odds ratio with a 95% confidence interval is suggested. The significance level considered for tests was 5%.

RESULTS

The study was conducted through the analysis of medical records of 100 obese adults seen at the Cardiology Outpatient Clinic of João de Barros Barreto University Hospital (HUJBB) in the city of Belém, PA, Brazil. Among these individuals, 60 had Metabolic Syndrome (MS) and 40 did not. The mean age of the studied population was 54 years, with a prevalence of females. There was no difference in the proportion of males and females in both groups (obese with MS and obese without MS). Regarding the degree of obesity, assessed by BMI and waist circumference, the two groups were statistically similar. Except for waist circumference and systolic blood pressure, individuals with MS showed unfavorable values for the variables assessing MS when compared to the group without MS ($P < 0.05$). In the group of obese individuals without MS, there were no individuals with abnormal values of triglycerides and fasting glucose. In the MS group, abnormal values were found for all components of MS. Table 1 provides a more detailed overview of the patient profiles, categorized into different groups.

Firstly, a comparison between the numerical variables was performed using the Student's t-test. For the variables „Diastolic Blood Pressure (PAD)" and „Low-Density Lipoprotein (LDL)," the p-values are greater than 0.05, suggesting that there is no significant difference between patients with and without Metabolic Syndrome (MS) for these variables. The other parameters showed p-values below 0.05, suggesting that there are statistically significant differences between the groups. The results are presented in Table 2.

Table 1. Distribution of Patients with and without MS

Variables	Obese with SM	Obese without SM	p
Age	56 ± 7.91	52 ± 4.76	<0.05*
Men Women	14 (35%) 26 (65%)	29 (48.3%) 31 (51.7%)	0.42
Waist Circunference (cm)	101.69 ± 7.78	101.27 ± 7.72	0.99
BMI	29.65 ± 4.26	31.38 ± 1.42	0.68
HDL colesterol (mg/dl)	42.97 ± 21.25	43.55 ± 5.23	<0.05
Triglycerides (mg/dl)	196.75 ± 87.43	131.46 ± 1.48	<0.001**
Blood Sugar (mg/dl)	136.80 ± 54.60	115.27 ± 7.72	<0.001**
Systolic BP (mmHg)	144.23 ± 23.81	141.50 ± 17.61	<0.001
Diastolic BP (mmHg)	81.90 ± 10.61	81.37 ± 8.47	<0.001**
MS components number	3=14 (23.3%) 4=19 (31.66%) 5=27 (45%)	1=14 (35%) 2=26 (655)	

Data presented as mean ± standard deviation or number (%). MS, metabolic syndrome; BMI, body mass index; HDL, high-density lipoprotein; BP, blood pressure, * p < 0.05 compared to the MS group. **p < 0.001 compared to the MS group

Table 2. Student's t-test for numerical variables

Parameter	P Value
Age	0.003
PAS	<0.001
PAD	0.78
IMC	0.001
CA – CM	0.002
HDL	<0.001
LDL	0.17
TRIG	0.004
Blood Sugar	<0.001
TC	0.003

PAS Systolic Blood Pressure; PAD Diastolic Blood Pressure; CA-CM Difference between Abdominal Circumference and Hip Circumference; HDL High-Density Lipoprotein; LDL Low-Density Lipoprotein; TRIG Triglycerides; CT total Cholesterol; RCV Cardiovascular Risk

The application of the Chi-square test aimed to evaluate the potential association between the obtained Framingham scores and the presence or absence of Metabolic Syndrome (MS) among the participants. For the male gender, the obtained value was significantly higher than the threshold of 0.05. For the female gender, the p-value was less than 0.05. This finding indicates the presence of a statistically significant difference in the Framingham score between women diagnosed with MS and those without the diagnosis. Based on these results, it is reasonable to assume the existence of an association between the presence of MS and the Framingham score in women. The results of the Chi-square test are shown in Table 3.

Table 3. Results of the Chi-square test for the Framingham score

Gender	χ^2	P Value
Masculine	0	1
Feminine	10,65	0.001

DISCUSSION

Metabolic syndrome (MS) is characterized as a complex disorder, with its development dependent on a complex interaction between genetic and environmental factors (inadequate diet, smoking, alcohol consumption, sedentary lifestyle, and anthropometric changes), combined with concurrent cardiovascular risk factors such as hypertension, hyperglycemia, central obesity, and insulin resistance.[1,2] Furthermore, these alterations also represent potential risk factors for cardiovascular diseases (CVD) and target organ damage (TOD), being significantly associated with higher mortality rates.[3] Obesity has been described as an inflammatory pathology capable of generating risk factors for cardiovascular diseases.[4,5]

However, there exists a condition known as isolated obesity (IO), characterized by a body mass index (BMI) of ≥30 kg/m² and meeting all criteria: serum triglycerides ≤150 mg/dL, serum HDL cholesterol >40 mg/dL (in men) or >50 mg/dL (in women), systolic blood pressure (SBP) ≤130 mmHg, diastolic blood pressure (DBP) ≤85 mmHg, without antihypertensive treatment as an alternative indicator, fasting glucose ≤99 mg/dL, without medication with hypoglycemic agents.[6,7] Thus, it's a condition defined as the absence of any metabolic disorder and/or cardiovascular disease, including type 2 diabetes, dyslipidemia, hypertension, and atherosclerotic cardiovascular disease (ASCVD) in a person with obesity.[8,9]

Data from large epidemiological studies and meta-analyses demonstrate that individuals with IO are at a higher risk of ASCVD, cerebrovascular disease, heart failure, cardiovascular events, type 2 diabetes, and all-cause mortality compared to metabolically healthy individuals with normal body mass index (BMI). A retrospective cohort study by KRAMER et al[10]

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with adults aged 18 to 65 found that out of 18,070 individuals analyzed, 1,805 (10%) had IO (mean age 38±11 years) and 3,047 had normal weight and were metabolically healthy (mean age 35±11 years).[3,5] After an average follow-up of 15 years, 80% of IO patients versus 68% of metabolically healthy individuals developed at least one cardiovascular and/or metabolic risk factor. There was a consistent increase in the rate of metabolic syndrome components developing in IO individuals, compared to metabolically healthy individuals, with glucose dysregulation developing more rapidly, and women having a tendency to develop MS over men.[11,12]

The homogeneity of the sample in terms of the subjects' degree of obesity in this study was essential to mitigate confounding, considering that the groups with and without MS did not statistically differ in terms of BMI and waist circumference (WC) values. As for the other variables of MS, the unfavorable average presented by the MS group compared to the non-MS group confirms the difference in the metabolic profile of both groups, something that demonstrates the adequacy of the sample to answer the question posed by this study. In our sample, the MS group had a higher average age than the non-MS group, with an average age of 56.4 years for the non-MS group and 52.21 with MS. Age is a risk factor for CVD, being associated with modifications in cardiac structure and function, even in healthy individuals.

In the Chi-square test application, for the female participants' group, the p-value was less than 0.05, while for the male segment of the sample, the presence of MS and the Framingham score could not be rejected, due to the fact that the obtained p-value was significantly higher than the threshold of 0.05. Based on these findings, a greater concern for women in disease screening and control is suggested, which could also signify lower adherence of men to healthcare. Furthermore, the higher prevalence of cardiovascular risk in women in the present study may be related to hormonal, circulatory, and blood-related changes that occur due to menopause and climacteric syndrome[13,14]. These alterations are implicated in the development and aggravation of cardiovascular disease, especially among the middle-aged population, being the main cause of mortality in this age group.[15]

Regarding anthropometric parameters, BMI, used to identify the degree of generalized obesity, both groups had elevated values, classified as obese.[16] In the study by FERNANDES et al, conducted with MS patients, the mean BMI was 32.8±5.5, equivalent to Grade I Obesity, similar to the average found in the present study for the MS group.[17,18] Thus, obesity plays an important role in the development of MS and CVD due to its association with other risk factors such as insulin resistance, hyperglycemia, increased blood pressure levels, and dyslipidemia. Additionally, the distribution of body fat, especially in the abdominal region, is related to metabolic alterations and a significant cardiovascular risk factor.[19] In this context, waist circumference (WC) measurement would be the best indicator of visceral adiposity, with central obesity related to 20% of cardiovascular events such as acute myocardial infarction.[20,21] In the present study, both MS and non-MS patients had elevated WC, with an average above 101 cm for both groups, which is similar for both genders, corroborating findings from other studies with individuals with MS.

Regarding blood pressure levels, systolic blood pressure (SBP) was elevated only for MS patients, above 140 mmHg, while diastolic blood pressure remained within normal range in both studied populations. Hypertension (HTN) is another diagnostic criterion for MS closely related to the risk of developing cardiovascular pathologies.[22] Although the risk of CVD is higher for higher blood pressure levels, especially systolic, this relationship is maintained even in mild hypertensives, such as the population of this study. Excess weight and central obesity are also suggested to be related to the development of systemic arterial hypertension.[23]

As for the biochemical tests, the mean fasting glucose levels were elevated in both groups, with 136.80 mg/dL for MS and 101.27 mg/dL for non-MS. Difficulty in glycemic control is a characteristic aspect of individuals with type 2 diabetes, both due to low adherence to hypoglycemic medications and maintaining diets with low carbohydrate intake.[17] Thus, chronic hyperglycemic conditions lead to increased levels of circulating advanced glycation end products (AGEs) and their accumulation in the body, increasing apolipoprotein B (ApoB-AGE) levels in the plasma and subsequently depositing them in the vascular endothelium, contributing to atherosclerosis.[17,23] Therefore, chronic hyperglycemia poses a greater risk of CVD, and the presence of type 2 diabetes results in higher morbidity and mortality, as well as a higher number of hospitalizations.

As for total cholesterol levels, there was no significant elevation in both groups, but MS patients had values above the normal range, with an average of 234.45 mg/dL. LDL cholesterol levels were within the recommended range for both groups. Regarding triglyceride levels, only the MS group had significant elevations in serum levels, with an average of 196.75 mg/dL. As for HDL levels, the average was reduced for the female gender in both groups, i.e, below 40 mg/dL. The lipid profile findings in this study indicate the classical involvement of metabolic syndrome, characterized by elevated levels of TC, TG, and LDL, combined with reduced HDL, which determines a high cardiovascular risk.[24] All MS group patients were using hypoglycemic, antihypertensive, or lipid-lowering drugs according to the treatment of their respective underlying conditions.

These findings are consistent with a similar study conducted with MS patients, among which the average TC was 248.1±48.8 mg/dL, TG was 383.8±45.6 mg/dL, and LDL was 128.3±39.3 mg/dL. The association of hypertriglyceridemia, LDL accumulation, and cardiovascular mortality, along with an inverse relationship between HDL levels and the risk of CVD events, implies a multiplicative effect on overall cardiovascular risk[25]. In general, atherosclerosis generated by dyslipidemia leads to the formation of atherosclerotic plaques in the endothelial wall, resulting in long-term vascular dysfunctions, especially in target organs, and early cardiovascular mortality. Hence, MS has been linked to cardiovascular events, and as such, several instruments are available for cardiovascular risk assessment (CVR). Notably, the Framingham risk score (FRS) is a useful and easy-to-use tool. It classifies individuals into low, moderate, and high risk of developing cardiovascular disease over the next ten years, through a scoring system that aids in defining therapeutic approaches. The prevalence of high cardiovascular risk assessed by FRS was found in 86% of the studied population, with CVR significantly related to HTN, low levels of HDL cholesterol, and female gender.

The results of this study revealed that hypertensive and obese patients with MS had higher FRS, which was also observed in another study. MS increases CVR through mechanisms involving hyperglycemia, peripheral vascular resistance, increased TG and LDL production, atherosclerosis, prothrombotic and systemic pro-inflammatory states, all of which begin with insulin resistance generated by obesity.[25,26] It is known that the presence of at least three components of MS increases cardiovascular mortality by about 2.5 times. Furthermore, the prevalence of moderate and high CVR was statistically more evident in adults with MS, and the number of components influenced CVR, similar to other research.[27,28]

These findings are consistent with current studies in which obese individuals, even without MS, present up to two MS components and are thus exposed to the deleterious effects of such metabolic disorders on the cardiovascular system. The methodological limitations of this study may be considered in the development of subsequent work. The absence of a control group composed of eutrophic individuals precluded establishing a causal relationship between MS and cardiac alterations.

FINAL CONSIDERATIONS

Furthermore, it emphasizes the importance of not underestimating cardiovascular risk in individuals with metabolically benign obesity (MBO), i.e, those without the formal diagnosis of MS. The study underscores that patients with MBO also deserve attention and proper care for cardiovascular health. These results indicate that these specific components of MS have significant implications for cardiac health and highlight the importance of controlling blood pressure and promoting healthy HDL levels as crucial strategies in preventing cardiovascular issues.

A key message derived from this study is the significance of prevention regarding Cardiovascular Risk (CVR) and MS. Healthcare professionals in primary care play a vital role in early identification, education, and the implementation of effective preventive measures. The collaboration between primary care and specialists is essential to provide comprehensive care to the population, addressing prevention, diagnosis, and proper treatment. When care is effective and individuals at high CVR, including those with a diagnosis of MBO and MS, are identified, professionals can create personalized plans to adopt a healthier lifestyle and provide guidance on health management.

Thus, this study underscores the complex interplay between obesity, Metabolic Syndrome, and cardiovascular health. The conclusions reinforce the need for an integrated approach in clinical practice, spanning from prevention to treatment, with a focus on promoting healthy habits and raising awareness about cardiovascular risks. The work of healthcare professionals plays a pivotal role in mitigating the impact of these conditions on the population and improving patients' quality of life.

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AUTHORS' CONTRIBUTIONS

All authors contributed substantially to the design and/or planning of the study; in obtaining, analyzing and interpreting data; in writing and critical review; and approved the final version to be published.

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DATA AVAILABILITY

The raw data that support the conclusions of this article will be made available by the authors, without undue reservations.

DECLARATIONS

ETHICAL APPROVAL AND CONSENT TO PARTICIPATE

Ethical review and approval was not required for the study on human participants as per local legislation and institutional requirements. Patients/participants provided their written informed consent to participate in this study. All authors contributed significantly, and all authors agree with the content of the manuscript.

CONSENT FOR PUBLICATION

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