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ORIGINAL ARTICLE

Association of Central Obesity with The Incidence of Cardiovascular Diseases and Risk Factors

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Abstract

Background: Obesity has been identified as a major risk factor for cardiovascular disease.

Objective: To evaluate the association of central obesity with the incidence of cardiovascular diseases and risk factors.

Methods: This was a cross-sectional study, carried out with patients treated at a metabolic syndrome outpatient clinic, with body mass index ≥ 24.9 kg/m^2. Nutritional status, laboratory tests (lipid and glycemic profile) and blood pressure status were analyzed. Participants were stratified into groups regarding the presence or absence of risk factors: diabetes, hypertension, and dyslipidemia.

Results: Women (n = 39), mean age of 44.18 ± 14.42 years, of which 70% were obese and 38% were hypertensive, corresponded to most of the studied sample. Abdominal circumference was 110.19 cm ± 15.88 cm; levels of triglycerides were 153.72 mg/dL ± 7.07 mg/dL; and fasting glycemia was 188.6 mg/dL ± 116 mg/dL. A significant association was found between the waist/height ratio and the findings of hypertension (p = 0.007); between visceral fat volume and diabetes (p = 0.01); between the conicity index and the findings of hypertension (p = 0.009) and diabetes (p = 0.006). No significant association was found between body mass index and waist circumference with findings of hypertension, diabetes and dyslipidemia.

Conclusion: Central obesity was associated with a higher incidence of development of risk factors related to cardiovascular diseases. (Int J Cardiovasc Sci. 2017;30(5):416-424)

Keywords: Obesity; Cardiovascular Diseases; Risk Factors; Metabolic Syndrome; Abdominal Circumference.

Introduction

Metabolic Syndrome (MS) is a condition in which risk factors for cardiovascular disease and diabetes mellitus occur in the individual,[1] represented by the combination of at least three of the following five components: abdominal obesity; hypertriglyceridemia; low High-Density Lipoprotein-cholesterol (HDL) and Low-Density Lipoprotein (LDL); arterial hypertension; and fasting hyperglycemia.[2] Among the metabolic alterations associated with abdominal obesity that contribute to the increase in the occurrence of MS, the glycemic disorder is significant, which is associated with the risk of cardiovascular disease (CVD).[3]

Obesity is defined as excess body fat, resulting from the chronic imbalance between food consumption and energy expenditure, which has been growing annually and acquiring alarming proportions.[4]

The World Health Organization (WHO) indicates obesity as one of the most important public worldwide health problems. In 2014, more than 1.9 billion adults were overweight. Of these, 600 million are already obese. From 1980 to 2013, both obesity and overweight increased 27.5% among adults and 47.1% among children.[5]

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In Brazil, obesity rates grow continuously. Some surveys indicate that over 50% of the population has excess weight, that is, in the overweight and obesity range.[6,7]

According to the 2008-2009 Household Budget Survey (HBS), there has been an inversion of groups in the Brazilian food pyramid: the fruit and vegetable group exchanged places with the groups of oils and fats, and sugars and soft drinks groups, demonstrating that these foods are highly consumed.[7] Inadequate consumption of fruits and vegetables and excessive consumption of foods high in fats and sugars are associated with the development and increased incidence of obesity and other chronic noncommunicable diseases, such as CVD.[7-9]

CVD is the leading cause of death in Brazil and worldwide. Data published by the WHO indicate that around 27% of the world's mortality records were caused by CVD, while in Brazil they were responsible for 31% of deaths.[8] This epidemiological scenario is of concern, because it implies a decrease in the quality of life of populations, as well as high and increasing costs for the government, society, family and individuals.[9]

In view of the above, the present study is justified by the influence of MS occurrence on the risk of developing CVD and the effects of these disorders on the health status of the individual, which are becoming more frequent in the population. Therefore, it is necessary to study the anthropometric and biochemical parameters of patients with MS to help health professionals working specifically with this group.

The aim of this study was to evaluate the association of central obesity with the incidence of cardiovascular diseases and risk factors.

Methods

This is a cross-sectional study of patients treated at the Metabolic Syndrome Outpatient Clinic of the Faculdade de Nutrição Emília de Jesus Ferreiro, Universidade Federal Fluminense (UFF), from March to November 2016. The project was approved by the Ethics and Research Committee of the School of Medicine of UFF, under number 59604916.0.0000.5243. All patients signed the Free and Informed Consent form.

The study included patients who met the following criteria: female gender, aged between 18 and 59 years, with a Body Mass Index (BMI) > 24.9 kg/m^2 and the requested biochemical tests.

Weight, height and waist circumference were used to evaluate the nutritional status, after being measured at the routine consultation. The weight was measured on an Even® electronic scale with a total capacity of 300 kg. To measure height, a stadiometer with a total capacity of 200 cm and a minimum capacity of 100 cm was used. Based on these measurements, the BMI [weight (kg)/height (m)²] was calculated. The WHO classification was used to evaluate BMI: normal weight if the BMI was between 18.5 and 24.9 kg/m^2; overweight, if between 25.0 to 29.9 kg/m^2; and obesity between 30.0 and 34.9 kg/m^2.[7]

Abdominal obesity was defined based on the abdominal circumference cut-off point for the increased cardiovascular risk in women (≥ 80 cm), as defined by the American Heart Association (AHA).[10] For the waist-to-height ratio (WHtR), the cutoff point used was the median one found in the sample (50th percentile) of 0.65.[11] The Visceral Fat Volume (VFV) was estimated by using a predictive equation, which uses WHtR and Fasting Glycemia (FG) as independent variables. The cutoff point of 100 cm^2 was considered for the VFV.[12] The conicity index was calculated through the Valdez formula, and the value of 1.18 was considered the best cutoff point.[13]

FG was assessed considering adequacy cutoffs up to 99 mg/dL for healthy subjects and those individuals with FG ≥ 126 mg/dL[14] or those who used hypoglycemic agents were classified as having diabetes; as for triglycerides (TG), values up to 150 mg/dL were considered adequate.[15] The values adopted by the American Heart Association (AHA)[16] were used for High-Density Lipoprotein (HDL) values, being considered adequate when > 50 mg/dL for women; Low Density Lipoprotein (LDL) calculation was performed using Friedewald formula,[17] with values < 160 mg/dL being considered adequate.[15,16] Patients with values above the pre-established ones or who were taking lipid-lowering drugs were considered as having dyslipidemia.

Patients who had a medical diagnosis of hypertension and those who used classes of antihypertensive drugs defined for hypertension drug treatment: diuretics, adrenergic inhibitors, direct vasodilators, calcium-channel blockers, Angiotensin-converting enzyme inhibitors (ACEIs), AT1 receptor blockers and direct renin inhibitors, were classified as hypertensive.[18] People who had no previous diagnosis of hypertension and who did not use antihypertensive drugs were excluded from the sample.

Statistical analysis

The results are expressed as descriptive statistics as mean ± standard deviation, and normality was verified by the Shapiro-Wilk test. Because of medication use, we chose to use categorical data (diagnosis) to verify the association between anthropometric measures and the presence of diabetes, hypertension or dyslipidemia, using Fisher's exact test, so that medication use did not influence the analysis, also calculating the odds ratio (OR) to verify the associations between anthropometric indexes and risk factors for cardiovascular diseases. Due to the sample size, we chose not to use prevalence ratios. The results were considered significant when $p < 0.05$. GraphPad Prism 5.0 software was used for these analyses.

Results

The Metabolic Syndrome outpatient clinic treated 98 patients during the study period; of these, 60 were women, but only 39 met all the pre-established inclusion criteria and agreed to sign the Free and Informed Consent form.

According to the BMI, 30% (n = 12) of the patients had nutritional status of overweight and 70% (n = 27) were obese, and 63% of the obese patients were over 40 years old. Table 1 shows the anthropometric data of this population.

Regarding risk factors, 38% (n = 15) of the sample had hypertension; 26% (n = 10), diabetes; and 79% (n = 31) had dyslipidemia (Table 2). It is possible to observe that 95% (n = 37) of the studied population had an abdominal circumference ≥ 80 cm, and almost half of the sample (48%; n = 19) had TG levels >150 mg/dL.

The statistical analysis showed an association between waist-to-height ratio (WHtR) and hypertension findings ($p = 0.007$). Regarding the other parameters, diabetes and dyslipidemia, no significant results were found (Table 3).

The association between VFV and the findings of hypertension, diabetes and dyslipidemia are shown in table 4. A significant association ($p = 0.01$) was found between VFV and diabetes, but no significant association was found when other parameters were analyzed.

The association between the conicity index and findings of hypertension ($p = 0.009$) and diabetes ($p = 0.006$) showed significant results. Although no association was found regarding dyslipidemia, according to the risk ratio, a 6.6-fold increased chance was observed in the studied population for the development of dyslipidemia (Table 5).

The association between BMI and the findings of hypertension, diabetes and dyslipidemia is shown in table 6, and no association was found between the analyzed parameters. However, according to the calculation of the risk ratio, an increased chance was observed in the studied population for the development of hypertension (3.6-fold), diabetes (2.5-fold) and dyslipidemia (3.3-fold).

No association was observed between abdominal circumference and the findings of hypertension, diabetes and dyslipidemia at the cutoff point used (≤ 80 cm and ≥ 80 cm).

Table 1 – Overall sample characterization

Characteristics	Mean ± SD	Min-Max
Age, years	44.18 ± 14.42	18-60
Weight, kg	90.48 ± 20.25	52.4-132.2
Height, m	159.6 ± 7.1	150-175
BMI, kg/m^2 (overweight)	27.67 ± 1.44	25.1-29.44
BMI, kg/m^2 (obesity)	37.78 ± 8.03	31.5-54.32
Waist circumference, cm	110 ± 16.07	80.0-140.0
Waist-to-height ratio	0.69 ± 0.1	0.55-0.88
Visceral fat volume, m^3	96.8 ± 90.1	63.2-492.1
Conicity index	1.34 ± 0.09	1.16-1.57

Values expressed in absolute numbers. SD: standard deviation; BMI: body mass index.

Table 2 – Risk factors found in the studied population, by groups

Factor	N	%	Mean ± SD	Min-Max
Overweight	11	30	27.67 ± 1.45	25.1-29.45
Obesity	28	70	37.78 ± 8.04	31.5-54.32
Abdominal circumference ≥ 80 cm	37	95	110.19 ± 15.88	89-142
Triglycerides > 150 mg/dL	19	48	153.72 ± 7.07	151-394
HDL < 50 mg/dL	14	36	47.97 ± 11.95	29-48
LDL > 160 mg/dL	2	5	182.5 ± 30.4	161-204
Fasting Glycemia > 126 mg/dL	10	26	188.6 ± 116	129-396
Hypertension	15	38	-	-
Dyslipidemia	31	79	-	-

Table 3 – Association between waist-to-height ratio and hypertension, diabetes and dyslipidemia

Cutoff point	≥ 0.65	< 0.65	p value	OR
Hypertensive	12	2	0.007*	8.7
Non-hypertensive	9	18		
Diabetics	6	15	0.26	2.9
Non-diabetics	3	17		
Dyslipidemics	13	6	1	0.9
Non- dyslipidemics	15	7		

*Values expressed in absolute numbers. * Fisher's exact test (p < 0.05). OR: odds ratio.*

Discussion

The population analyzed in the study was mostly classified as obese, according to the mean BMI, in addition to showing higher mean values of abdominal circumference, conicity index, and WHtR than the cutoff points established for the evaluation of abdominal obesity. Despite this fact, they had a mean VFV < 100 cm^2.

The prevalence of obesity in the study (70% of the population) is noteworthy, as it is a relatively young and still active population, which shows the impact of current eating habits on health. It can be observed that 95% of the sample had abdominal obesity, which is an important risk factor for CVD and other associated morbidities.

Similar findings were observed by Petribú et al.[19], who observed a population with 517 women with a median age of 29 years, of which 32.5% was overweight and more than half of the sample with abdominal and non-visceral obesity when waist circumference, WHtR and VFV were analyzed. The authors call attention to the fact that women tend to accumulate subcutaneous fat in the abdominal region, which may justify the findings.

The prevalence of abdominal obesity has increased in recent years and is currently higher than the prevalence of overall obesity, especially in women.[20] This can also be observed in our study, which found a prevalence of 70% of overall obesity and 95% of abdominal obesity, according to the abdominal circumference.

It was observed that 48% of the patients studied had dyslipidemia and, of these, 46% were obese. This fact can be explained by the accumulation of adipose tissue and the release of free fatty acids, which are easily directed to the

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Table 4 – Association between visceral fat volume and hypertension, diabetes and dyslipidemia

Cutoff point	≥ 100 cm²	< 100 cm²	p value	OR
Hypertensive	12	1	0.09	8.4
Non-hypertensive	10	7		
Diabetics	15	1	0.01*	15
Non-diabetics	7	7		
Dyslipidemics	16	2	0.07	6.6
Non- dyslipidemics	6	5		

*Values expressed as absolute numbers. * Fisher's exact test ($p < 0.05$). OR: odds ratio.*

Table 5 – Association between the conicity index and hypertension, diabetes and dyslipidemia

Cutoff point	≥ 1.33	≤ 1.33	p value	OR
Hypertensive	12	9	0.009*	7.1
Non-hypertensive	3	16		
Diabetics	11	10	0.006*	9.9
Non-diabetics	2	18		
Dyslipidemics	16	6	0.06	3.6
Non- dyslipidemics	8	11		

*Values are expressed in absolute numbers. * Fisher's exact test ($p < 0.05$). OR: odds ratio.*

Table 6 – Association between body mass index and hypertension, diabetes and dyslipidemia

Cutoff point	Overweight	Obesity	p value	OR
Hypertensive	2	12	0.15	3.6
Non-hypertensive	9	15		
Diabetics	2	9	0.44	2.5
Non-diabetics	7	18		
Dyslipidemics	3	13	0.17	3.3
Non-dyslipidemics	10	3		

*Values expressed as absolute numbers. * Fisher's exact test ($p < 0.05$). OR: odds ratio.*

liver for a higher production of TG and Very Low-Density Lipoprotein (VLDL).[15,21] Therefore, it is possible to associate this complication with the increased risk of developing CVD, which is directly related to obesity.[20,22]

There was an increase in the prevalence of abdominal obesity in the population. In women, this could be attributed to the higher concentration of body fat commonly reported in females, due to pregnancies and hormonal differences. This is added to the fact that the aging process causes a decrease in growth hormone production, basal metabolic rate and a natural reduction in physical activity levels, as well as a worsening of healthy eating habits, thus progressively increasing the redistribution of fat; thus, women start to accumulate more abdominal fat.[20-22]

The WHtR has been pointed out as an effective way of discriminating abdominal obesity related to cardiovascular risk factors.[11,23]

In the present study, it was necessary to use other cutoff points for the WHtR, in addition to those suggested in the literature, since it was observed that most of the sample was above this range; thus, we used a cutoff point of 0.65 for WHtR, which represents the 50^{th} percentile of the sample.

The women in the study with WHtR above the cutoff point had a higher frequency of hypertension when compared to those below the cutoff. This finding corroborates current studies, which demonstrate that visceral fat accumulation tends to compress renal mechanics, which is a determinant of higher sodium absorption in the proximal segments of the nephron, causing the activation of the renin-angiotensin aldosterone system in the dense molecule for the preservation of renal plasma flow and glomerular filtration rate. Hydrosaline retention, and increased blood pressure and intraglomerular pressure levels would occur through this mechanism.[24]

Regarding the conicity index, some authors suggest a variation between 1.0 (a perfect cylinder) and 1.73 (a perfect double cone) at the cutoff points; the increase in values agrees with fat deposition in the central region of the body, that is, the closer to 1.73, the greater the central fat deposition.[25-27]

According to Andrade et al.[25], who studied the conicity index in women and their association with hypertension and diabetes mellitus, women with high conicity index values had 72% and 75% more chances of having diabetes mellitus and hypertension, respectively.

Pitanga and Lessa[27] suggested 1.18 as the best cutoff point the conicity index in Brazilian females of fertile age, with sensitivity (73.39%) and specificity (61.15%) values, as well as area under the ROC (Receiver Operating Characteristic) curve of 0.75 (95% Confidence Interval - 95% CI = 0.70-0.80). The authors concluded that the conicity index can be used to discriminate cardiovascular risk even if the sensitivity and specificity values are not very high. However, incorrect classifications are possible, which leads to a greater number of false-positive results.[27]

In the present study, we used 1.33, the median value of the sample, as the cutoff point for the conicity index, since only 4% (n = 1) of the population had an index < 1.18. This parameter was associated with hypertension ($p = 0.009$) and diabetes ($p = 0.006$), which are risk factors for CVD. These findings corroborate those found by Ghosh et al.[28], who compared the association of obesity indicators and eating habits with metabolic risk factors for heart disease, and found an association between high conicity index with high blood glucose, TG and total cholesterol levels.

This fact can be explained because adipose tissue is influenced by several signals, such as insulin, cortisol and catecholamines, and, in response, it secretes other substances that act both locally and systemically, participating in several metabolic processes. Some of these secreted substances, such as leptin, adiponectin, Tumor Necrosis Factor Alpha (TNF-a), among others, play a key role in insulin resistance, with abdominal fat having the greatest impact on this process. This fact suggests that this is a consistent indicator in the association of body fat distribution with cardiovascular risk factors.[28,29]

The literature also reports that there is a lower tendency in women to have areas of visceral adipose tissue when compared to men. However, they have greater areas of subcutaneous fat.[12,19,29]

The metabolic behavior of visceral fat differs from that of subcutaneous adipose tissue. The first is more subject to lipolysis, expressing a greater number of glucocorticoid receptors and is more sensitive to catecholamines, showing a lower expression of IRS-1, which leads to a greater deterioration of insulin sensitivity and an increase in blood pressure and in the atherosclerotic process. For these reasons, VFV quantification is important, since the visceral fat deposition profile is more associated with CVD.[29]

Computed tomography, nuclear magnetic resonance and ultrasonography are the best methods of VFV quantification, but they have disadvantages, such as the high cost.[30,31]

Several studies have developed predictive equations to estimate VFV, which are easy to use and low cost. Most of them have been performed in populations that are very different from the Brazilian population and in male individuals.[19,30-32] The equation developed by Petribú et al.[19] is the one closest to the study population.

In the present study, VFV showed a high-risk chance for diabetes mellitus and a slight chance for systemic hypertension. However, the sample had a mean of 96 cm^2 of VFV, that is, it was below the established cutoff point.

Piernas Sánchez et al.[31] obtained similar data in their study, in which they applied a predictive equation to a population of women with a mean age of 39 ± 2 years and mean BMI of 29 ± 5 kg/m^2. The authors observed that, even though they were overweight, had high body fat percentage and high cardiovascular risk, according to the waist circumference, the women had subcutaneous fat, and not visceral fat, according to the VFV.

These authors draw attention to the fact that women tend to gain more subcutaneous fat in the abdominal than in the visceral region, which could justify the observed results.

When analyzing the BMI with risk factors for cardiovascular diseases, no association was observed with these parameters. The BMI is the most popular measure among health professionals to diagnose obesity because it is easy to apply. However, this index does not predict body fat distribution and does not distinguish lean mass from fat mass, and should be associated with other anthropometric parameters of body fat distribution to establish an increased risk of developing CVD, which is directly associated to central fat deposition.[32,33]

Regarding the measurement of abdominal circumference, the studied sample can be diagnosed with abdominal obesity and increased risk for CVD, with a mean of 110 ± 16.07 cm. However, this measure showed no association with the analyzed risk factors, highlighting only a slight risk of dyslipidemia. This finding can be explained by the fact that age is one of the important risk factors for CVD development[19,20,30] and the studied population had a mean age of 44.18 ± 14.42 years, suggesting that women who participated of this study did not yet have some of the assessed morbidities, since they were still fertile (10 to 49 years).[34,35] During menopause, changes in body fat distribution increase the risk of cardiovascular and metabolic diseases.[35,36]

In a study carried out in Africa with 169 postmenopausal women, abdominal circumference was correlated with systemic arterial hypertension. The results can be explained by the typical hormonal changes that occur in menopause, most prevalent at this age, when women are more vulnerable to metabolic diseases, such as dyslipidemia and systemic arterial hypertension, and which may increase the risk of CVD.[36]

Other studies have shown equivalent results. Moraes et al.[37] found a high percentage of participants with an increased risk for CVD. Silva[38] found 91.6% of females with altered abdominal circumference and BMI. Cristóvão et al.[4] investigated women treated at the Family Health Strategy units in the eastern region of São Paulo and observed that 57.4% of the participants had values >80 cm.

The multiplicity of anthropometric indicators to estimate obesity contributed to the selection of one of them that considered criteria such as the studied population, gender, age and, mainly, evidence based on population studies or clinical interventions. It is worth noting that tools are needed to take the necessary measurements, which must be always available and feasible. Through the results shown in this study, it is suggested that all the anthropometric indicators used showed different performances to differentiate cardiovascular risk in women.

This study has as limitations the small number of participants in the sample, due to resource limitations, non-assessment of the participants' ethnicity and patients who missed the consultations. Furthermore, the diagnosis of hypertension and/or diabetes was reported by the participants according to the knowledge of prior medical consultations.

Conclusion

Overweight and obesity were observed in the studied population, which showed greater accumulation of fat in the abdominal region, associated with diseases such as systemic arterial hypertension, diabetes mellitus and dyslipidemias. These facts are of concern, as they are associated with the risk of developing cardiovascular diseases, increased metabolic complications and other health problems.

Author contributions

Conception and design of the research: Barroso TA, Marins LB, Barroso SG, Rocha GS. Acquisition of data: Barroso TA, Marins LB, Alves R, Gonçalves ACS, Barroso SG, Rocha GS. Analysis and interpretation of the data: Barroso TA, Marins LB, Alves R, Gonçalves ACS, Barroso SG, Rocha GS. Statistical analysis: Barroso TA, Marins LB, Alves R, Barroso SG, Rocha GS. Obtaining financing: Barroso TA, Marins LB, Barroso SG, Rocha GS. Writing of the manuscript: Barroso TA, Marins LB, Barroso SG, Rocha GS. Critical revision of the manuscript for intellectual content: Barroso TA, Marins LB, Alves R, Barroso SG, Rocha GS. Supervision / as the major investigador: Barroso TA, Marins LB, Barroso SG, Rocha GS.

Potential Conflict of Interest

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

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