Prevalence of Visceral Obesity Estimated by Predictive Equation in Young Women from Pernambuco

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Abstract

Background: The accumulation of visceral fat is considered a major risk factor for cardiovascular and metabolic diseases.

Objective: To determine the prevalence of visceral obesity and to assess its association with cardiovascular risk factors in young women from the state of Pernambuco.

Methods: Cross-sectional study carried out with data from the "III Health and Nutrition State Survey", involving women aged 25 to 36 years. The following variables were evaluated: body mass index (BMI), Waist Circumference (WC), waist-to-height ratio (WHtR), volume of visceral fat (VVF) estimated by a predictive equation, Systolic and Diastolic Blood Pressure (SBP, DBP), total cholesterol (TC), Triglycerides (TG), fasting glucose (FG).

Results: A total of 517 women were evaluated, with a median age of 29 years (27-32) and prevalence of visceral obesity of 30.6%. BMI, SBP, DBP and TG were higher in the group with visceral obesity: BMI = 28.0 kg/m2 (25.0 to 21.4) vs. 23.9 kg/m2 (21.5 to 26.4) , SBP = 120.0 mmHg (110.0 to 130.0) vs. 112.0 mmHg (100.0 to 122.0), DBP = 74 mmHg (70-80) vs. 70 mmHg (63-80); TG = 156.0 mg / dL (115.0 to 203.2) vs. 131.0 mg / dL (104.0 to 161.0), respectively, p ≤ 0.01. Age, SBP, DBP, TG and TC levels were significantly and positively correlated with the VVF: r = 0.171, 0.224, 0.163, 0.278, 0.124 respectively, p ≤ 0.005.

Conclusion: A high prevalence of visceral obesity was observed, being statistically correlated with cardiovascular risk factors. (Arq Bras Cardiol 2012;98(4):307-314)

Keywords: Subcutaneous rat, abdominal; prevalence; risk factors; cardiovascular diseases; body mass index; blood pressure; dyslipidemias; women.

Introduction

Abdominal obesity, considered a risk factor for several morbidities[1], consists of two distinct fat compartments: subcutaneous and visceral fat[2]. Several authors have shown that visceral, but not subcutaneous fat, is associated with several deleterious effects, such as high levels of triglycerides (TG), low high-density lipoprotein (HDL-C), insulin sensitivity[3,4], hyperglycemia, C[4] peptide, metabolic syndrome[3-5], endothelial dysfunction[6], hepatic and muscle steatosis, low levels of peptin and adiponectin[4], and smaller and denser low density lipoprotein (LDL)[7]. Thus, the accumulation of visceral fat is considered a major risk factor for cardiovascular (CVD) and metabolic diseases[7].

Although the exact molecular mechanism responsible for this association is unknown, the effect may occur due to the anatomical location of fat within the abdomen or the differences in metabolic properties[3].

Thus, the reduction of visceral fat can be a preventive measure for the metabolic syndrome and CVD[7]. The measurement of Visceral Adipose Tissue (VAT) has therefore particular implication on public health[8] and the reliability of its measurement is of great clinical importance[9].

Few studies have determined the prevalence of visceral obesity in different populations[10-12], probably due to the limitations of radiological methods, capable of differentiating the components of abdominal fat in subcutaneous and visceral fat, in addition to the inability of anthropometric measurements to represent the VAT area particularly[13]. Computed tomography (CT), Magnetic Resonance Imaging (MRI) and ultrasonography (USG) have high cost, limited availability of equipment and submit the individuals undergoing assessment to radiation (CT)[14,15], preventing their use for the assessment in large groups of individuals, precluding its use as a screening tool for the population[16].

Therefore, this study aimed to determine the prevalence of visceral obesity in young women from the state of Pernambuco, Brazil, based on a predictive equation, and to evaluate the association of visceral fat with risk factors for CVD.

Methods

The present was a cross-sectional population-based study, based on data from the ""III Health and Nutrition State Survey", (PESN III)", held in urban and rural areas of Pernambuco between May and October 2006.

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The present study involved adult females aged 25 to 36 years of age. To calculate the sample size, we considered the prevalence of visceral obesity of 28.7%[11], an estimation error of 4% and a confidence level of 95%, totaling 491 individuals. The III PESN database contained 669 women aged 25 to 36 years; however, of these, 152 were excluded due to lack of clinical data, and thus a total of 517 women who had all the variables used in this study were enrolled. The III PESN adopted as exclusion criteria pregnant women and women with physical limitations that impaired the anthropometric measurements.

Height was measured using a portable stadiometer (Alturaexata Ltda.) with a precision of 1 mm. The subjects were positioned upright, barefoot, with upper limbs hanging on the sides of the body, and heels, back and head touching the wooden column. Weight was measured using a digital scale (Model MEA-03200/Plenna) with a capacity of 150 kg and 100-gram scale, with the individual barefoot and wearing light clothing. To ensure their accuracy, two weight and height measurements were obtained, and when the difference exceeded 0.5 cm in height and 100 g in weight, the measurement was repeated and the two closest measurements were written down, and the mean value was used.

Nutritional status was classified using weight and height measurements through the Body Mass Index (BMI), by adopting the cutoffs recommended by the World Health Organization (WHO), 1998[17].

Waist Circumference (WC) was measured in duplicate at the midpoint between the last rib and the iliac crest, with a tape measure, following the WHO protocol, 1998[18], and values ≥ 80 cm were considered high[18].

The Waist-to-Height Ratio (WHtR) was determined by dividing the WC (cm) by the height (cm) and the cutoff point adopted for discrimination of abdominal obesity and cardiovascular risk was ≥ 0.53[19].

The measurements of total cholesterol (TC), triglycerides (TG) and fasting glucose (FG) were measured in venous blood by cubital puncture after a 12-hour overnight fast. Plasma concentrations of TC and TG were determined by absorption photometry with enzymatic method. The reference values were those recommended by the III Brazilian Guidelines on Dyslipidemia[20]. The FG measurement was performed using the Accutrend GCT equipment, read immediately after venipuncture, and the cutoff points adopted were those recommended by the American Diabetics Association, 2010[21].

The diastolic and systolic blood pressures (SBP and DBP) were determined using a calibrated aneroid sphygmomanometer (Premium EC 0483), adopting the protocol and classification of the VI Brazilian Guidelines on Hypertension (2010)[22].

The volume of visceral fat (VVF) was estimated using the predictive equation proposed by Petribú[23] that uses as independent variables the WHtR and FG, as follows:

$$VVF = -130.941 + (198.673 \times WHtR) + (1.185 \times FG);$$

This equation, developed from a multiple regression analysis by adopting the USG as a reference standard, is capable of predicting the VVF in approximately 45%, with a standard error of estimate of ± 15.19 cm^2. The validation was performed by comparing the VVF measured by the equation and measured by ultrasonography in a group of women not participating in the stage of development of the equation using the Student's *t* test for paired samples, with no statistically significant difference between the values (54.28 ± 9.79 *vs.* 53.36 ± 7.94, respectively, p = 0.760)[23]. At an additional step, to assess the agreement between the two methods, the Bland Altman was carried out and there was a good agreement, with a bias close to zero (Figure 1). A cutoff of 100 cm^2 was adopted for the diagnosis of visceral obesity[24].

The database was compiled using the Epi Info software release 6.04 (CDC/WHO, Atlanta, GE, USA), with double entry, and further use of the validation mode to check for any typing errors. For statistical analyses, we used the SPSS software, release 10.0 (SPSS Inc., Chicago, IL, USA). Continuous variables were tested according to the normal distribution using the Kolmogorov-Smirnov test. When they had a non-normal distribution, they were transformed to their natural logarithm and retested for normality (age, weight, SBP, DBP, FG, TG, TC, BMI, VVF). When they maintained the non-normal distribution (age, SBP, DBP, FG, TC), they were described as median and interquartile range and the non-parametric tests were applied.

The comparison between the medians was carried out by nonparametric Mann Whitney test. The association between continuous variables was performed by Spearman's linear correlation test. The significance level was set at 5% to reject the null hypothesis.

The III PESN research project was approved by the Research Ethics Committee in Humans of Instituto de Medicina Integral Professor Fernando Figueira (IMIP), on January 12, 2006 (Protocol No. 709/2006). Women who agreed to participate in the study signed an informed consent form.

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Results

The women's median age was 29 years (CI: 27-32). In general, this was an overweight population according to BMI, in addition to a high concentration of abdominal fat, as shown by WC and WHtR. Regarding SBP and DBP, laboratory parameters (FG, TG and TC) and the VVF estimated by the predictive equation, the values corresponding to the mean or median were below the reference values (Table 1).

Regarding the nutritional status, there was a low prevalence of underweight and a high prevalence of overweight and obesity based on BMI. About 30% of the women had visceral obesity and more than half, abdominal obesity according to WC and WHtR (Table 2).

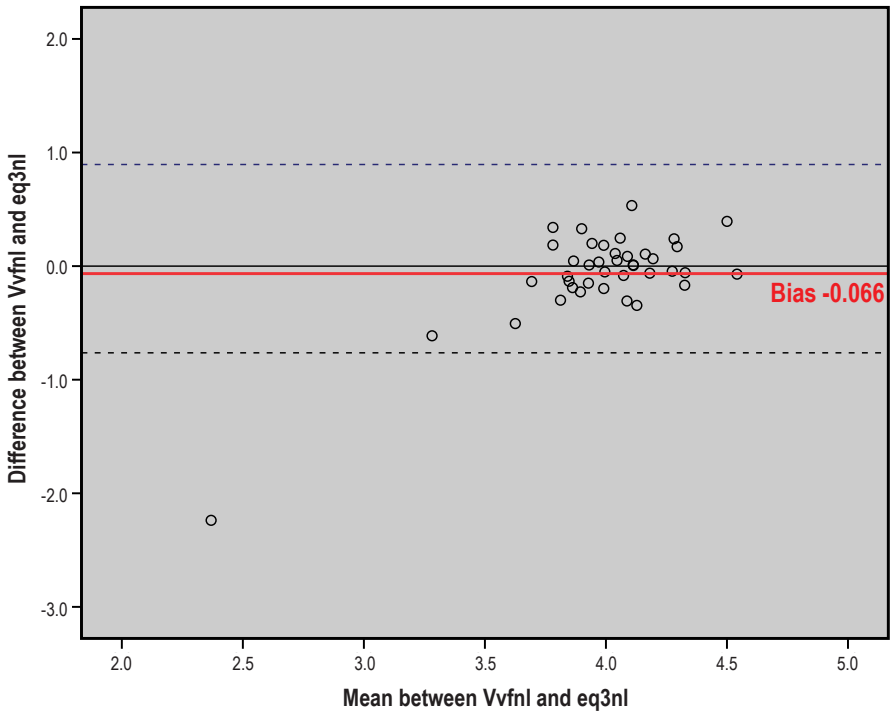

Figure 1 – *Agreement between ultrasound and the predictive equation of visceral fat assessed by the Bland Altman test; Vvfnl - volume of visceral fat natural logarithm evaluated by ultrasonography; eq3nl - natural logarithm of the volume of visceral fat estimated by predictive equation*

Table 1 – General characteristics of women aged 25 to 36 years in the state of Pernambuco, 2006

Variables	Women aged 25-36 years (n = 517)	
	Mean	SD
Age (yrs)*	29.0	27. 0 – 32. 0
Weight (Kg)	62.84	13.17
Height (m)	156.75	6.21
BMI (Kg/m2)	25.52	4.82
WC (cm)	85.11	12.20
WHtR	0.54	0.08
SBP (mmHg)*	116.0	101.0 - 126.0
DBP (mmHg)*	70.0	66.0 – 80.0
FG (mg/dl)*	88.0	78.0 – 103.0
TG (mg/dl)*	148.54	55.36
TC (mg/dl)*	163.0	150.0 – 182.0
VVF (cm2)	87.39	33.92

**Mediated and interquartile interval; BMI – body mass index; WC – waist circumference ; WHtR - waist-to-height ratio; SBP – systolic blood pressure; DBP – diastolic blood pressure; FG – fasting glucose; TG - serum triglycerides; TC - total cholesterol; VVF - volume of visceral fat estimated from the equation VVF = -130,941 + (198,673 x WHtR) + (1,185 x FG).*

About 10% of the women had SBP and/or DBP alterations. The prevalence of hyperglycemia was close to 30%, while almost 40% had increased TG. Regarding the TC, only 13% had hypercholesterolemia (Table 3).

Table 4 shows the comparison between the medians of BMI, SBP, DBP, TG and TC in women with and without visceral obesity. With the exception of TC, all parameters were higher in the group with visceral obesity ($p < 0.002$).

The correlations between SBP, DBP, TG and TC and VVF estimated from the equation are described in Figure 2.

All variables showed a positive and significant correlation with VVF, but such correlations were weak. Moreover, age also showed a significant and positive correlation with VVF ($r = 0.171$, $p < 0.0001$).

Discussion

The population analyzed in this study was classified as overweight according to their mean BMI, in addition to showing mean values of WC and WHtR above the cutoff in the evaluation of abdominal obesity. Nevertheless, they had a mean VVF < 100 cm². Similar data were observed by Piernas Sánchez et al[11], who applied a predictive equation to a population of 230 women, mean age 39 ± 12 years and mean BMI of 29 ± 5 kg/m², and observed that, despite

Table 2 – Nutritional status according to the body mass index and prevalence of visceral and abdominal obesity in women aged 25 to 36 years in the state of Pernambuco, 2006

Variables	Total		95%CI
	n = 517	%	
BMI			
< 18.5	19	3.7	2.3 – 5.8
18.5 a 24.9	242	46.8	42.4 – 51.2
24.9 a 29.9	168	32.5	28.5 – 36.7
≥ 30.0	88	17.0	13.9 – 20.6
VVF			
< 100 cm²	359	69.4	65.2 – 73.3
≥ 100 cm²	158	30.6	26.6 – 34.8
WC			
< 80 cm	192	37.1	33.0 – 41.5
≥ 80 cm	325	62.9	58.5 – 67.0
WHtR			
< 0.53	233	45.1	40.7 – 49.5
≥ 0.53	284	54.9	50.5 – 59.3

CI – confidence interval; BMI – body mass index; VVF - volume of visceral fat estimated from the equation VVF = -130,941 + (198,673 x WHtR) + (1,185 x FG); WC – waist circumference; WHtR – waist-to-height ratio.

Tabela 3 – Blood pressure, lipid and glycemic profile of women aged 25 to 36 years from the state of Pernambuco, 2006

	Total		95%CI
	n = 517	%	
SBP			
<140	467	90.3	87.4 – 92.7
≥ 140	50	9.7	7.3 – 12.6
DBP			
<90	475	91.9	89.1 – 94.0
≥ 90	42	8.1	6.0 – 10.9
FG			
≤ 99	369	71.4	67.2 – 75.2
> 99	148	28.6	24.8 – 32.8
TG			
< 150	312	60.3	56.0 – 64.6
≥ 150	205	39.7	35.4 – 44.0
TC			
< 200	450	87.0	83.8 – 89.7
≥ 200	67	13.0	10.2 – 16.1

CI - confidence interval ; SBP – systolic blood pressure; DBP – diastolic blood pressure; FG – fasting glucose; TG – serum triglycerides; TC - total cholesterol.

Table 4 – Comparison between the medians of cardiovascular risk factors in women aged 25 to 36 years from the state of Pernambuco. Brazil. 2006. with and without visceral obesity.

	normal VVF (< 100 cm²)		Increased VVF (≥ 100 cm²)		p*
	Md	IQ	Md	IQ	
IMC	23.9	21.5 – 26.4	28.0	25.0 – 31.4	<0.0001
IMC	112.0	100.0 – 122.0	120.0	110.0 – 130.0	<0.0001
IMC	70.0	63.0 – 80.0	74.0	70.0 – 80.0	0.01
IMC	131.0	104.0 – 161.0	156.0	115.0 – 203.2	<0.0001
IMC	161.0	150.0 - 180	164.0	152.0 – 189.0	0.22

*Md - mediated; IQ - interquartile interval; VVF - volume of visceral fat; *Mann-Whitney; BMI – body mass index; SBP – systolic blood pressure; DBP – diastolic blood pressure ; TG – serum triglycerides; TC - total cholesterol.*

being overweight, having high body fat percentage and high cardiovascular risk according to WC and WHtR, the women had subcutaneous, but not visceral fat. These authors stressed the fact that women tend to accumulate more subcutaneous fat in the abdominal region, which could explain these findings[11].

Unlike the above, Onat et al[25] found in their study, which also involved women classified as overweight with abdominal obesity according to the mean BMI and WC, respectively, a much higher mean of VVF than that of the present study (120.5 ± 58 cm²). It is noteworthy the fact that the study was conducted in a population with a mean age of 49 ± 8.7 years with a high prevalence of metabolic syndrome (34%)[25]. These authors emphasized the significant increase in VAT with age and a 42% higher mean in the group with metabolic syndrome[25], which may explain the difference observed when compared with the present study, which involved younger women, less likely to have metabolic syndrome. In relation to the increase in the VVF according to age, these results were also described by Pascot et al[26], who found a mean VVF of 63.7 ± 40.9 cm² in young women (27.4 ± 7.5 years) and 116.1 ± 67.5 cm² in middle-aged women (49.5 ± 5.3 years), with this difference being statistically significant. This study also showed a positive correlation between age and VVF.

Literature reports that the prevalence of abdominal obesity has increased over the last decade and now exceeds the prevalence of overall obesity, with rates of 61.3% in women[27,28]. Such evidence was also found in the present study, which found a prevalence of 17% of overall obesity and 62.9% of abdominal obesity according to the WC.

The prevalence of visceral obesity was lower than the abdominal obesity, which was expected, considering that the WC is more strongly associated with subcutaneous fat than with visceral fat, and that the aging process is associated with loss of subcutaneous fat and increased visceral fat[29], i.e., the study population, consisting solely of young adults, probably has a higher amount of subcutaneous abdominal fat than visceral fat. Moreover, Pou et al[29] called attention to the fact that, in their study, approximately one quarter of the obese individuals or with high WC did not have high VAT, while 10% of women and 20% of men with normal WC had high VAT, suggesting that there are misclassifications between the categories of clinical adiposity[29].

The prevalence of visceral obesity found in this study was similar to that described by Piernas Sánchez et al[11], who found a prevalence of 28.7% among women. Pou et al[29], when assessing 3,348 participants of the Framingham Heart Study Offspring and Third Generation Cohort with a mean age of 52.2 ± 9.9 years, found a prevalence of visceral obesity of 44% in females. However, in addition to the fact that the population was older than that in the present study, the authors used a cutoff for the classification of different visceral obesity[29] and this may have influenced the high prevalence observed.

In agreement with the findings of Tadokoro et al[10], it was observed that the BMI values were higher in group with visceral obesity. This finding was also described by Pou et al[29], who observed that the prevalence of VAT increased with the increasing BMI category.

When comparing the TG and TC levels between the groups with and without visceral obesity, there were statistically higher values in the first group only for TG. This finding can be explained by the fact that, with increasing VAT, free fatty acids are readily targeted to the liver for further production of glucose, TG, and very-low density lipoprotein (VLDL)[30]. Other studies also found higher serum TG levels in subjects with high VAT[4,29,31]. However, these studies found lower levels of HDL in these individuals[4,29,31]. A limitation of the present study was the fact that it did not assess cholesterol fractions (HDL, LDL and VLDL), as the fact that TC was not different between the two groups may be due to a possible decrease in HDL in the group with visceral obesity.

Tadokoro et al[10] and Reyes et al[31] did not observe any significant difference regarding TC values between the two groups.

Regarding blood pressure, SBP and DBP values were higher in the group with visceral obesity. However, this finding was not observed in other studies[4,10,31,32]. Romero-Corral et al[6] draw attention to the fact that the visceral fat is associated with endothelial dysfunction, even in the absence of blood pressure alterations. One possible explanation for the increase in BP found in individuals with visceral obesity is the fact that visceral adipokines and cytokines may contribute to insulin resistance[33]. Hyperinsulinemia can elevate blood pressure through the sympathetic nervous system activation, the impairment of

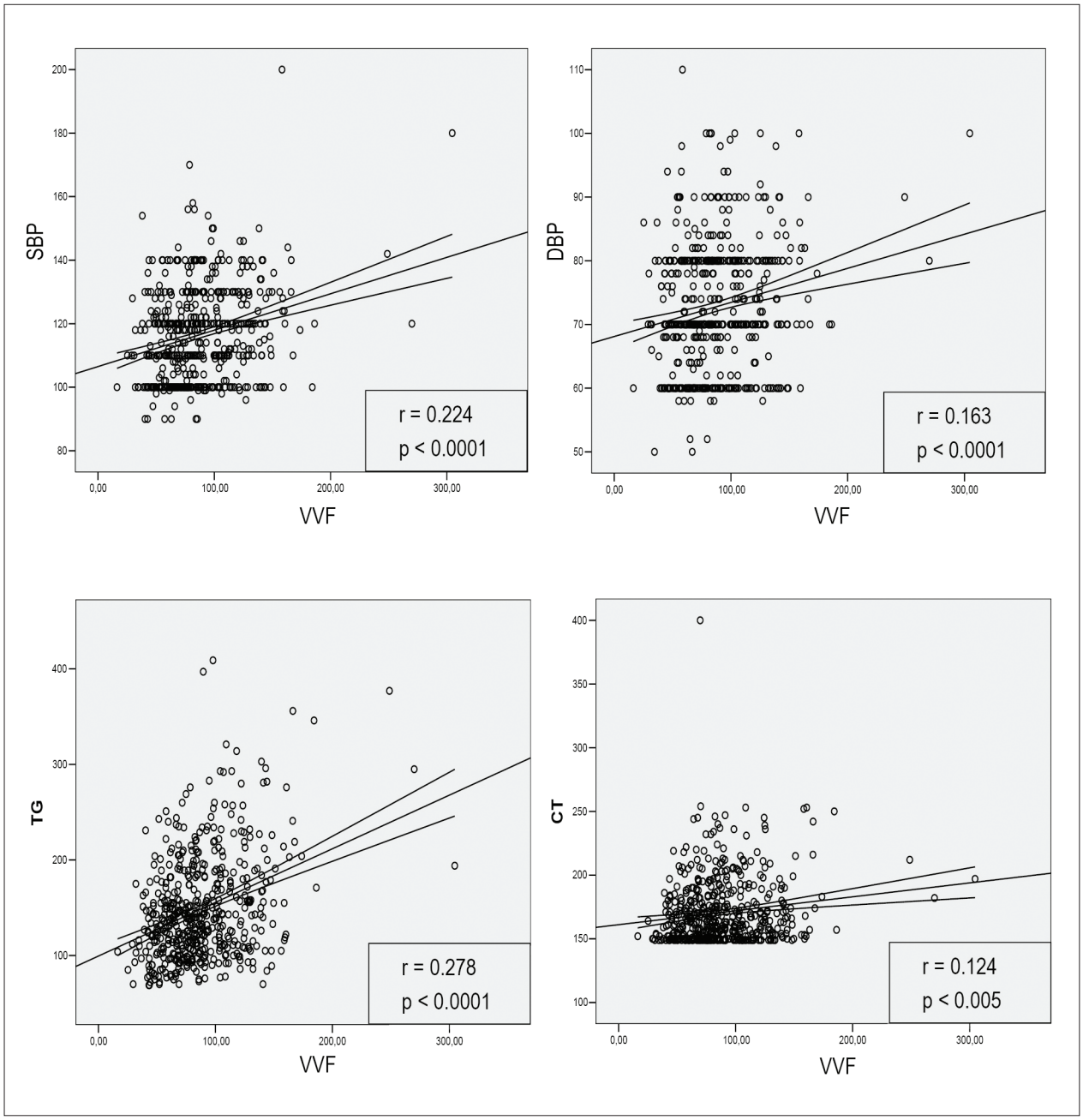

Figure 2 – *Correlation between the volume of visceral fat estimated from a predictive equation and systolic and diastolic blood pressure, serum triglycerides and total cholesterol in women aged 25 to 36 years from the state of Pernambuco, Brazil, 2006. VVF- volume of visceral fat ; SBP – systolic blood pressure; DBP – diastolic blood pressure; TG – serum triglycerides; TC - Total cholesterol; r – Spearman's correlation.*

peripheral vasodilation, an increased response to angiotensin and increased renal reabsorption of sodium and water, with consequent volume overload[34].

The VVF was positively correlated with multiple metabolic risk factors in this study (SBP, DBP, TG and TC). This finding was also observed by other authors[32,35]. Kotronen et al[32] found a positive and significant correlation between visceral fat and levels of TG, SBP and DBP (r = 0.36, 0.28 and 0.24, respectively) and a negative one with HDL (r = -0.38). Hayes et al[35] found, in severely obese women (BMI = 31-67 kg/m2), a significant positive correlation between intra-abdominal fat and SBP (r = 0.35), DBP (r = 0.31) and a negative one with HDL (r = -0.34). The correlation with the TG was close to statistical significance (r = 0.31, p = 0.054)[35]. Fox et al[36], studying individuals with a mean age of 50 years from the Framingham Heart Study, found a significant association between SBP (r = 0.30), DBP (r = 0.28), FG (r = 0.34), TG (r = 0.46) and HDL (r = -0.35) with VAT in women.

In turn, Tadokoro et al[10] found a significant and positive correlation between visceral fat and SBP and TG only in males, while the TC and DBP showed no significant correlation with visceral fat in both sexes. It was also observed a negative correlation between HDL and visceral fat in women, but this study was carried out with adolescents, with a mean age of approximately 15 years[10], which may have contributed to these findings.

A positive fact of the present study was that the participants were young adults, allowing the assessment of the association between fat compartment and cardiovascular risk factors in the absence of significant comorbidities. Limitations of the study include two main facts. First, the fact that it did not use imaging methods to determine the visceral fat (CT, MRI and ultrasonography), due to the high cost of these methods; however, this equation has been previously validated to be used in young Brazilian women. Secondly, the study has a cross-sectional design; thus, the associations are not prospective and causality cannot be inferred.

The prevalence of visceral obesity found (30.6%) draws attention to the fact that it is a young female population, which usually has less fat in the visceral region, compared to older and male individuals. The study also shows that visceral fat was correlated with age and risk factors for development of CVD (SBP, DBP, TC, TG). The reduction of visceral fat may therefore contribute to a lower incidence of CVD in later life. More studies are needed to prospectively evaluate the impact of VAT reduction on the incidence of risk factors associated with metabolic syndrome and CVD.

Potential Conflict of Interest

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

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Study Association

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