Criteria for Central Obesity in a Brazilian Population: Impact on the Metabolic Syndrome

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Objective: To identify and propose the optimal waist circumference cut-off points (WCp) for the diagnosis of central obesity (CO) in a Brazilian population, so as to compare these cut-off points with those recommended by the ATPIII (WC-ATPIII), and to estimate the difference in prevalence rates of metabolic syndrome (MS) using the two criteria.

Methods: Cross-sectional study conducted in a population subgroup of 1439 adults in the city of Salvador, Brazil. ROC curves of WC were plotted to identify diabetes mellitus (DM) and obesity. ROC curve sensitivity and specificity values ≥60% and the closest to each other were used to define WCp. The prevalence of MS was estimated using WCp and WC-ATPIII.

Results: Eight hundred and twenty nine women comprised 57.7% of the sample. The WCp selected were 84cm for women and 88cm for men. These cut-off points detected DM with a 68.7% and 70% sensitivity, and a 66.2% and 68.3% specificity, respectively. For obesity, sensitivity and specificity were 79.8% and 77.6% in women and 64.3% and 71.6% in men, respectively. Using WC-ATPIII, 88cm (for women) and 102cm (for men), the sensitivity was 53.3% and 26.5%, respectively, to diagnose DM. For obesity, sensitivity was 66.5% (for women) and 28.6% (for men). The prevalence of MS using WCp was 23.7%, 95%CI (21.6 – 25.9), whereas using WC-ATPIII it was 19.0%, 95%CI (17.1- 20.9), 1.2 times higher using WCp.

Conclusion: WC-ATPIII were inappropriate and underestimated the prevalence of MS in the population studied, particularly among men. We suggest that the WC cut-off points > 84cm for women and > 88cm for men should be tested in other Brazilian populations.

Key words: Central obesity, waist circumference, metabolic syndrome, brazilian population.

The metabolic syndrome (MS), common in individuals with central obesity, is associated with an increased risk of type 2 diabetes mellitus (DM)[1] and cardiovascular events[2]. With biological plausibility, central obesity is independently associated with MS components and with insulin resistance[3-6]. When compared to traditional anthropometric measurements, waist circumference (WC) has proven superior to body mass index (BMI) and to waist-hip ratio in the identification of visceral adiposity and, consequently, of cardiovascular risk[7-9].

The Third Report of National Cholesterol Education Program Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults – Adult Treatment Panel III – (ATP III) proposed a new definition for metabolic syndrome (SM), using WC values >102cm for men and > 88cm for women as a criterion for central obesity[10]. Originally described by Lean et al in 1995[11], these cut-off points have not been adequate to define obesity in some populations[12-15]. This fact was pointed out in the recently published review of the ATP III diagnostic criteria[16].

In Brazil, neither population-based studies on metabolic syndrome nor a specific criterion for central obesity for our population are available. The objectives of this study are: a) to identify the optimal WC cut-off point to diagnose central obesity in a urban Brazilian population; b) to compare the performance of the cut-off points obtained with those proposed by the ATP III; c) to estimate differences in the prevalence rates of MS as measured by the two criteria of abnormal WC.

Methods

Patients - This is a cross-sectional study using the sample of the Monitoring Non-Transmissible Chronic Diseases (MONIT) Project, conducted in Salvador[17]. Summarizing, for MONIT, the sample size was initially estimated at 1800 adults with age ≥ 20 years, based on a 25% prevalence of high blood pressure, 95% confidence interval and a 2% design error. A 20% loss of households (non-residential houses, family refuse, difficulties for resident access, and others) was expected. The sampling was conducted in three phases: 1) the census sectors of 8 out of 10 river basins in the city with similar social and demographic characteristics were grouped in 108 "Research Areas" and classified by socioeconomic level (SEL) as upper, middle or lower level. The areas contained 16592 households with approximately 83000 inhabitants, with age ≥ 20 years. In proportion to the number of sectors of each

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SEL of the Areas, 37 were probabilistically drawn by lot; 2) by systematic sample (interval = 10), 1540 households were drawn by lot, with a 18.3% loss and favorable response to participation of 1258 resident families in 63 census sectors; 3) in the third phase, the participants were drawn by lot, two per household at the most, one per gender, with the exclusion of pregnant women[17].

In the household, all participants answered a questionnaire on cardiovascular and DM risk factors; they had their blood pressure taken six times and their WC measured twice.

A total of 1437 individuals went to the Health Service for blood drawing and the results of biochemical analysis of interest were available to them. Those are the individuals comprising the population of the present study.

Six measurements were taken to check the blood pressure, and the average of the last five ones were used for the analysis. To obtain WC, individuals remained in an erect position, breathing softly, and a non-stretchable tape measure was placed around their natural waist line (narrowest part midway between the thorax and the hip), and the measurement was expressed as whole centimeters (cm). Height and weight measurements for BMI calculation were taken with standard equipment and the scale was periodically calibrated. Biochemical tests, performed after a 12-hour fast, were: blood glucose using Labtest in fluoridized plasma, cholesterol (Tender – enzyme method), triglycerides (modified Soloni method) and HDL-cholesterol (Labtest)

Criteria and definitions -

a) Skin color was self-defined in one of the three categories: white, mulatto or black;

b) socioeconomic level (SEL) – criterion used by the Instituto Brasileiro de Pesquisa Econômica Aplicada (Brazilian Institute of Applied Economics Research) and IBGE (Brazilian Institute of Geography and Statistics) in Brazil[18]. The original classification of brackets going from A to E was grouped for this study in A+B (upper SEL), C (middle SEL), and D+E (lower SEL);

c) schooling was classified as: high (complete high school or complete or incomplete college), middle (complete basic school or incomplete high school), and low (illiteracy, incomplete basic school);

d) Metabolic Syndrome-1 (MS-1) – we used the ATP III revised criterion[16] based on the coexistence, in the same individual, of three or more of these five factors: 1) High blood pressure (≥130/85 mmHg) or current pharmacological treatment for high blood pressure; 2) Dysglycemia (fasting plasma glucose ≥ 100 mg/dl) or current pharmacological treatment for DM (DMms); 3) WC > 88cm for women or > 102cm for men (WC-ATP III); 4) Low HDL-cholesterol (HDL-c) (< 40 mg/dL in men and < 50 mg/dL in women); 5) Hypertriglyceridemia (≥ 150 mg/dl);

e) Metabolic Syndrome-2 (MS-2) – the same criterion for MS-1, but replacing the WC cut-off point by that proposed (P) in this study – WCp.

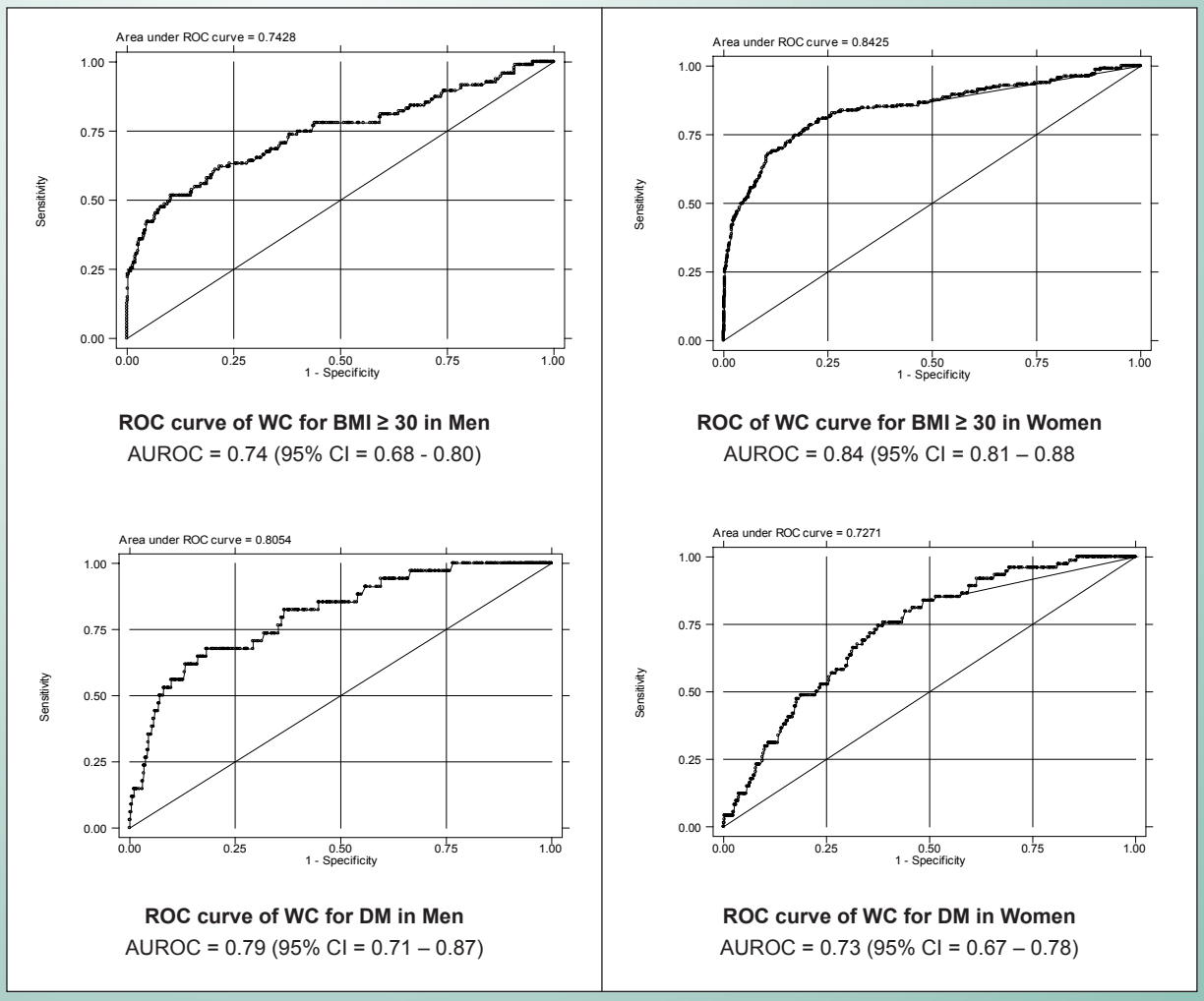
The project was submitted to and approved by the Medical Ethics Committee of the Regional Medical Council of the State of Bahia and all participants signed the Informed Consent Form.

Statistical analysis - Social demographic characteristics, prevalence of high blood pressure and WC measurements

	Men		Women	
	MONIT Population	Study Population	MONIT Population	Study Population
Mean Age ± SD	39.9±14.4	40.32±14.13	41.7±14.9	41.87±14.63
Skin Color %				
White	27.7 (24.9-30.5)	24.9 (21.4-28.3)	30.2 (27.6-32.7)	25.5 (23.5-29.6)
Mulatto	42.2 (39.4-44.9)	46.8 (42.8-50.8)	46.1 (43.0-49.2)	45.3 (41.9-48.7)
Black	26.1 (23.4-28.9)	28.3 (24.7-32.0)	27.6 (25.2-30.1)	28.1 (25.0-31.2)
SEL %				
Higher	15.5 (13.5-17.5)	12.0 (9.4-14.6)	14.9 (12.7-17.1)	10.4 (8.3-12.5)
Middle	28.9 (26.1-31.7)	28.2 (24.6-31.8)	30.1 (27.6-32.7)	29.6 (26.5-32.7)
Lower	56.1 (53.1-59.2)	59.8 (55.9-63.8)	54.4 (51.6-57.1)	59.9 (56.6-63.3)
Schooling %				
High	5.3 (3.9-6.6)	4.1 (2.5- 5.7)	4.8 (3.6- 6.0)	2.5 (1.5- 3.6)
Middle	53.2 (50.1-56.2)	50.5 (46.5-54.5)	50.6 (47.9-53.3)	48.4 (45.0-51.8)
Low	41.6 (39.5-44.6)	45.4 (41.4-49.4)	44.6 (41.8-47.3)	49.1 (45.7-52.5)
WC (mean±SD)	83.7±10.6	83.6±10.2	80.6±12.4	80.8±12.3
BP (mean±SD)				
Systolic	126.4±20.2	127.92±21.02	119.5±24.8	121.77±25.93
Diastolic	78.5±16.5	78.89±15.08	75.4±15.0	76.19±14.26
HBP %	28.0 (25.4-30.7)	27.5 (23.9-31.0)	30.2 (27.7-32.7)	32.2 (29.0-35.4)

SD - standard deviation/ SEL - socioeconomic level/ HBP - high blood pressure/ WC - waist circumference/ BP - blood pressure.

Table 1 - General Characteristics of the Study Population



AUROC - *area under the* ROC *curve;* CI - *confidence interval*/ DM - *diabetes mellitus;* WC - *waist circumference*/ BMI - *body mass index.*

Fig. 1 – ROC *curves of* WC *for the identification of* DM *and obesity.*

in the population studied were compared with those of the reference population to identify possible selection biases.

ROC (Receiver Operating Characteristic) curves of WC were plotted according to the diagnosis of DM and obesity (BMI ≥ 30) to select the optimal WC cut-off point that could identify CO in each gender. Statistical significance of each analysis was determined by the area under the ROC curve and by the 95% confidence interval (95% CI). The criterion used to select the WC cut-off points for each gender were the closest values of sensitivity and specificity between each other, no lower than 60%, which could, in order of priority: a) diagnose, with a good level of accuracy, obese individuals among the population; b) identify, by using this WC cut-off point, DM, the metabolic disorder that is most directly related to insulin resistance. These WC values were used in the analyses as the WC cut-off points proposed for central obesity (WCp). Also, ROC curves of WC were plotted to identify components of MS.

Using both waist circumference criteria – WCp and WC-ATP III – prevalence rates and 95% CI of the other components of MS were calculated, according to ATP III definition (DMms, HBPms, low HDL-c, hypertriglyceridemia), among individuals with an abnormal WC. Prevalence rates of central obesity and MS and their respective 95% CI were also calculated, and prevalence ratios (PR) obtained from these cut-off points were estimated.

The odds ratios (OR) to discriminate individuals with a higher cardiovascular risk in the range of normal BMI and overweight according to the new WC cut-off points were estimated using the logistic regression model. Confounding was defined as a difference greater than or equal to 10% between crude and adjusted OR. Eligibility of confounding variables used in the logistic regression model also considered the scientific knowledge available in the literature. Interaction was assessed by the maximum likelihood ratio test, considering $p < 0.05$ as the statistical significance level.

	Area under the ROC curve	Sensitivity		Specificity	
		WCP	WC-ATP III	WCP	WC-ATP III
			Women		
DMms % (95% CI)	0.72 (0.67 - 0.77)	65.9 (62.7-69.1)	51.1 (47.7-54.5)	68.4 (65.3-71.6)	77.8 (75.0-80.6)
HBPms % (95% CI)	0.74 (0.70 - 0.77)	58.3 (54.9-61.6)	46.4 (43.0-49.8)	76.2 (73.3-79.1)	85.4 (83.0-87.8)
HDL ↓ % (95% CI)	0.58 (0.54 - 0.62)	41.4 (38.0-44.7)	30.0 (26.9-33.1)	67.2 (64.0-70.4)	76.3 (73.5-79.2)
TG ↑ % (95% CI)	0.69 (0.65 - 0.73)	56.4 (53.0-59.8)	40.8 (37.5-44.2)	69.7 (66.6-72.8)	78.1 (75.2-80.9)
DM	0.73 (0.67 - 0.78)	67.0 (64.4-70.7)	54.0 (50.7-57.4)	65.8 (62.6-69.1)	75.8 (72.8-78.7)
BMI ≥ 30 % (95% CI)	0.84 (0.81 - 0.88)	79.8 (77.1-82.5)	69.5 (66.3-72.6)	77.6 (74.8-80.4)	87.8 (85.6-90.0)
			Men		
DMms % (95% CI)	0.73 (0.68 - 0.79)	60.0 (56.1-63.9)	18.7 (15.6-21.8)	69.7 (66.0-73.3)	95.6
HBPms % (95% CI)	0.68 (0.63 - 0.72)	47.8 (43.9-51.8)	10.3 (7.9-12.7)	75.5 (72.1-78.9)	96.6 (95.2-98.1)
HDL-c ↓ % (95% CI)	0.59 (0.54 - 0.65)	42.8 (38.8-46.7)	11.0 (8.5-13.5)	69.2 (65.5-72.9)	95.6 (94.0-97.3)
TG ↑ % (95% CI)	0.72 (0.67 - 0.76)	51.7 (47.7-55.7)	10.6 (8.2-13.1)	74.8 (71.4-78.3)	96.0 (94.4-97.6)
DM	0.79 (0.71 – 0.87)	68.7 (65.1-72.4)	21.9 (18.6-25.2)	67.7 (64.0-71.4)	94.6 (92.8-96.4)
BMI ≥ 30 % (95% CI)	0.74 (0.68 - 0.80)	64.3 (60.5-68.1)	28.6 (25.0-32.2)	71.6 (68.0-75.1)	98.0 (96.9-99.1)

WC - *waist circumference;* BMI - *body mass index;* CI - *confidence interval;* HBPms - BP ≥ *130/85 mmHg or current treatment;* DMms - *fasting plasma glucose ≥ 100 mg/dl or treatment for* DM; HDL ↓ - HDL < *40 mg/dL in men and < 50 mg/dL in women;* TG ↑ - *triglycerides ≥ 150 mg/dL;* WCp - WC *cut-off point recommended by the present study (> 84cm for women and 88cm for men);* WC-ATPIII - WC *cut-off point recommended by the* ATP III *(> 88cm for women and 102cm for men).*

Table 2 - Performance of WC cut-off points in the identification of components of MS, DM, and obesity

The STATA™ version 7.0 statistical package was used in the analyses.

Results

Most of the characteristics of the 1437 individuals studied were similar to those of the original MONIT sample. A greater number of individuals with low levels of schooling, and consequently lower socioeconomic levels were observed in the first group (Tab. 1).

Identification of the WC cut-off points - The area under the ROC curve of WC to identify DM among women was 0.73% (95% CI = 0.67-0.78) (Fig. 1). The 84cm WC cut-off point offered the best balance between sensitivity (67.6%) and specificity (65.8%) in predicting DM, and corresponds to the WCp for this gender (Tab. 2). The area under the ROC curve was 0.79 (95% CI = 0.71-0.87) among men, and the optimal cut-off point was 88cm, with a 68.7% sensitivity and 67.7% specificity (Tab. 2). This was the optimal WCp obtained for men. The two WCp identified HBPms, HDL-c < 50 mg/dL and hypertriglyceridemia with reasonable levels of sensitivity and specificity (Tab. 2).

The 88cm cut-off point for women and 102cm cut-off point for men recommended by the ATP III identified DM with a 54% and 21.9% sensitivity, respectively. These rates are significantly lower, from a statistical and epidemiological point of view, than those of the WCp. Using the ATP III cut-off points, a loss of sensitivity and increase in specificity were observed (Tab. 2).

Again, using the ROC curve we can observe that the 84cm WCp for women was also the one that best identified obesity (BMI ≥ 30 Kg/m^2) among women (Tab. 2), with a 79.8% sensitivity and a 77.6% specificity (Fig. 1). Among men, the optimal cut-off point to identify obesity was 86cm, with a 68.4% sensitivity and a 66.7% specificity. However, the 88cm cut-off point had a similar performance (64.3% sensitivity and 71.6% specificity) (Tab. 2), and was assumed as the cut-off point defining central obesity (WCp) among men. Using the 88cm cut-off point for women and 102cm cut-off point for men defined by the ATP III, we observed a loss of sensitivity, particularly among men (28.6%), and a slight increase in specificity in the identification of obesity (Tab. 2).

The prevalence of each of the MS components (DMms,

	Women		Men	
	WCp n=308	WC-ATP III n=223	WCp n=208	WC-ATP III n=38
DMms % (95% CI)	28.9 (23.8 – 34.0)	30.9 (24.8 – 37.0)	23.1 (17.3 – 28.8)	39.5 (23.2 – 55.7)
HBPms % (95% CI)	60.7 (55.2 - 66.2)	66.8 (60.6 - 73.0)	58.2 (51.4-64.9)	68.4 (52.9 - 83.9)
HDL-c ↓ % (95% CI)	56.8 (51.2 - 62.4)	56.9 (50.4 - 63.5)	35.6 (29.0-42.1)	50.0 (33.3 - 66.6)
TG ↑ % (95% CI)	39.9 (34.4 - 45.4)	39.9 (33.4 - 46.4)	51.4 (44.6 - 58.3)	57.9 (41.4 - 74.3)

MS - metabolic syndrome; WC - *waist circumference;* HDLc ↓ - HDL-c *< 50 mg/dL for women and < 40 mg/dL for men;* TG ↑ - *triglycerides ≥ 150 mg/dL;* DMms - *fasting plasma glucose ≥ 100 mg/dL or treatment for* DM; HBPms - BP *≥130/85 mmHg or treatment for* HBP. WCp - WC *cut-off point recommended by this study (> 84cm for women and > 88cm for men)* WC-ATP III - WC *cut-off point recommended by the* ATP III *(> 88cm for women and > 102cm for men).*

Table 3 - Prevalence of Components of MS among individuals with Central Obesity Defined by the two Criteria

HBPms, low HDL-c, and triglycerides ≥ 150 mg/dL) in the cut-off points selected for this population and in those recommended by the ATP III is shown in Table 3.

Impact of the WC cut-off points on the prevalence of MS - When the prevalence rates of MS and central obesity based on the two cut-off points are compared, we observe that those estimated using the WCp are significantly higher than those based on WC-ATP III. The overall prevalence of MS calculated based on criteria of abnormal WCp was 1.2 times higher than that estimated using the WC-ATP III (Tab. 4). The age-adjusted prevalence estimated from the WCp among men was 22.2% (95% CI = 19.0-25.4), a rate 1.5 times higher than that calculated using the WC-ATP III, which was 14.4% (95% CI = 11.4-17.7). This difference was less marked among women, and was approximately 1.1 times (Tab. 4). Similarly, the prevalence rates of central obesity defined using these two criteria in both genders were higher using WCp, especially among men (Tab. 4).

Assessment of the ability to identify cardiovascular risk among non-obese individuals - With the exception of HDL < 40 in males, the analyses of the association between central obesity defined by WCp and the factors that comprise MS in individuals within the range of normal BMI or overweight demonstrate that, even among non-obese individuals, the abnormal WCp was able to discriminate individuals at a higher risk, even after adjustment for age, schooling, socioeconomic level, self-attributed skin color, smoking, alcohol consumption, and physical activity (Tab. 5). Central obesity defined using WCp was also associated with the presence of two or more factors comprising the MS in the same individual, in a statistically significant manner for both genders (Tab. 5).

Discussion

For different reasons, we can admit that the WC cut-off points recommended by the ATP III for defining central obesity are inappropriate for the population studied. Using these criteria as risk markers, we observe a loss of sensitivity, with underestimation of the diagnosis of obesity, dysglycemia, HBPms, dyslipidemias, and, consequently, of MS, particularly among men. Considering that DM is a condition strongly correlated with MS, and that the 88cm WC cut-off point for women and 102cm for men were associated with this condition with a sensitivity of only 54% and 21.9%, respectively, we can say that these cut-off points underestimate the role of abdominal obesity as a predisposing factor to DM. Consequently, the use of this criterion may impair timely decision-making for preventing not only MS and DM, but also severe cardiovascular complications.

The 88cm WC cut-off point identified in this study as a criterion for central obesity in men was the same described by Pitanga & Lessa to identify overall cardiovascular risk in individuals between 30 and 74 years of age in the MONIT sample[19]. Among women, the cut-off points were very similar (83cm). However, we should point out that in the present study, in addition to the inclusion of individuals over 20 years of age, we also sought to identify the presence of metabolic disorders. WC is known to be an excellent marker of visceral obesity, and this type of obesity is known to be the one with the strongest association with metabolic disorders. Perhaps this explains why, despite identifying very similar cut-off points, the WC showed a moderate performance in Pitanga & Lessa's study when compared to the conicity index and to waist-hip ratio in the identification of overall cardiovascular risk, whereas in the present study the accuracy of WC in identifying metabolic disorders, particularly dysglycemia, was high.

The choice of the criterion to define the cut-off points of continuous variables for the classification of normal and abnormal may vary according to the nature of what is being studied, and to the phase of knowledge on the results of treatments and preventive measures. There is a constant tendency to reduce cut-off points, as periodically occurs with the diagnosis of high blood pressure and dyslipidemias[20,21]. In the context of the identification of MS, we consider that the best criterion for the choice of the WC cut-off point would be the balance point between sensitivity and specificity. If, on one hand, sensitivity is important to recognize the greatest possible number of individuals at risk, on the other hand, a good specificity would help rationalize diagnostic and therapeutic resources, since MS is a high risk condition for CVD and DM.

	WCp		WC-ATP III		
	Crude Prev. % (95% CI)	Age-adjust. Prev. % (95% CI)	Crude Prev. % (95% CI)	Age-adjust. Prev. % (95% CI)	Adjust.* PR
Metabolic Syndrome					
Overall (n=1437)	23.7 (21.5 - 25.9)	23.7 (21.6 - 25.9)	19.0 (17.0 - 21.0)	19.0 (17.1 - 20.9)	1.2
Women (n=829)	25.4 (22.5 - 28.4)	24.8 (22.1 - 27.6)	22.9 (20.0 - 25.8)	22.4 (19.8 - 24.9)	1.1
Men (n=608)	21.4 (18.1 - 24.6)	22.2 (19.0 - 25.4)	13.6 (10.9 - 16.4)	14.4 (11.4 - 17.7)	1.5
Central Obesity					
Overall (n=1437)	35.0 (32.5 - 37.5)	35.0 (32.6 - 37.4)	18.0 (16.0 - 20.0)	18.0 (16.1 - 20.0)	1.9
Women (n=829)	36.1 (32.8 -39.3)	35.4 (32.3 - 38.5)	26.7 (23.6 - 29.7)	26.3 (23.8 - 28.7)	1.3
Men (n=608)	33.5 (29.8 - 37.3)	34.4 (30.8 - 38.1)	6.2 (4.3 - 8.2)	6.8 (3.9 - 9.7)	5.1

*MS - metabolic syndrome; CO - central obesity; WC - waist circumference; WCp - WC cut-off point recommended by this study (> 84cm for women and > 88cm for men); WC-ATPIII - WC cut-off point recommended by the ATP III (> 88cm for women and > 102cm for men); 95% CI - 95% confidence interval; *Adjust PR - Age-adjusted Prevalence using WCp and WC-ATP III.*

Table 4 - Prevalence of MS and CO estimated with the two WC cut-off points

	Men		Women	
	Non-adjusted OR (95% CI)	Adjusted OR (95% CI) *	Non-adjusted OR (95% CI)	Adjusted OR (95% CI) *
DMms	2.78 (1.59 - 4.88)	2.22 (1.19 - 4.13)	3.82 (2.35 - 6.21)	2.34 (1.35 - 4.03)
HBPms	2.56 (1.72 - 3.82)	2.26 (1.45 - 3.51)	2.97 (1.99 - 4.43)	1.73 (1.08 - 2.77)
HDL-c ↓	1.53 (1.00 - 2.33)	1.50 (0.93 - 2.42)	1.56 (1.06 - 2.32)	1.84 (1.20 - 2.82)
TG ↑	2.58 (1.71 - 3.88)	2.07 (1.33 - 3.24)	2.90 (1.90 - 4.42)	2.56 (1.63 - 4.04)
≥ 2 factors	2.69 (1.79 - 4.06)	1.97 (1.25 - 3.09)	3.67 (2.45 - 5.49)	2.57 (1.64 - 4.01)

*WCp - WC cut-off point recommend by this study (> 84cm for women and > 88cm for men); BMI - body mass index; HDLc ↓ - HDLc < 50 mg/dL for women and < 40 mg/dL for men; TG ↑ - triglycerides > 150 mg/dL; DMSM - fasting plasma glucose ≥ 100 mg/dL and/or treatment for DM; HBPms - PA ≥130/85 mmHg and/or treatment for HBP; WCp - WC cut-off point recommended by this study (> 84cm for women and > 88cm for men); * Adjusted for age, schooling, socioeconomic level, self-attributed skin color, smoking, alcohol consumption and physical activity.*

Table 5 - Odds Ratios of the association of MS components with central obesity (defined by WCp) in non-obese individuals

The WCp sensitivities obtained in this study were higher than those of the ATP III, whereas the latter were more specific. If CO and other elements of the MS are easy to diagnose at a low cost, and if all of them can be prevented, controlled or eliminated, then we consider that a good sensitivity is desirable, although some specificity is lost. This seems rational, considering, on one hand, that MS repercussions have a high individual and social cost, and on the other hand, that false-positive individuals could have their diagnosis easily excluded with low-cost reexaminations, without further psychological trauma.

The criteria for abnormal WC recommended by the ATP III have been applied and validated as markers of abdominal obesity and as a risk factor for cardiovascular diseases and DM, especially in populations of Western developed countries[7,22-24]. However, these criteria cannot be applied to other populations with distinct ethnical components, and therefore with anthropometric characteristics which are also different. Thus, other WC cut-off points have been proposed and used for defining central obesity in populations outside the USA and Europe[12-15,25-27].

According to the criteria of abnormal WC proposed by the ATP III, prevalence rates of age-adjusted MS in the American population were 24.0% for men and 23.4% for women[28]. These prevalence rates are very close to those calculated for this study's population using the WCp (20.5% for men and 23.1% for women).

Since the cut-off points for WCp are lower than the WC-ATP III, concern would remain, for this reason, that they would not keep a strong association with the risk factors that comprise the MS, thus affecting the role of central obesity measurement as a discriminator of cardiovascular risk even superior to BMI. However, these cut-off points were observed to keep a strong association with components of MS, even in individuals with a normal BMI or overweight, both for women and men (Tab. 5).

Considering the criteria for abnormal WC defined in this study as the most appropriate to define central obesity, the use of the WC cut-off point proposed by the ATP III would imply a diagnostic failure of 25.7% among women, and 80.2% among men. Consequently, the diagnostic failure of MS would be 39% among men and 23.4% among women. From a clinical and social point of view, these values are significant and may result in the lack of specific preventive measures and, consequently, in the progressive increase of type 2 DM cases and cardiovascular diseases.

The Brazilian Society of Hypertension jointly with other medical societies elaborated the I Brazilian Guidelines on the Diagnosis and Treatment of Metabolic Syndrome[29]. In the absence of nationwide data, this document recommends the same WC cut-off points originally proposed by the ATP III as a diagnostic criterion for central obesity. The present study may bring a new contribution, both for further population-based studies on WC cut-off points in Brazil, and for future guidelines, helping to establish diagnostic criteria for central obesity which are more appropriate for the Brazilian population.

Considering the better performance of the cut-off points proposed here in relation to those of the ATP III, we recommend WC > 84cm cut-off points for women and > 88cm for men as diagnostic criteria for central obesity, and suggest that they be tested in other populations in Brazil.

Study limitations - The partial data loss of more than 30% of the initial sample of individuals who did not attend the appointment for fasting blood collection may have introduced a selection bias. Greater or slightly lower losses have been widely observed in literature, representing one of the setbacks to epidemiological research. Since the characteristics of the reference population and of the population studied are similar, particularly as regards to the prevalence of high blood pressure and WC measurement, we believe that this data loss has not affected our results.

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Potential Conflict of Interest

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

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