

Waist Circumference and Body Mass Index as Predictors of Hypertension

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Objective: To evaluate the association between anthropometric indexes – body mass index (BMI) and waist circumference (WC) – and hypertension, and to evaluate the predictive value of these indexes in detecting hypertension.

Methods: Cross-sectional population study conducted in the city of Goiânia (GO) with a sample of 1,238 adults aged twenty to 64 years, in 2001. Total obesity was defined as BMI ≥ 30 kg/m²; abdominal obesity was defined as level 2 WC ≥ 88 cm for women and ≥ 102 cm for men, and hypertension was defined as systolic pressure ≥ 140 mmHg, or diastolic pressure ≥ 90 mmHg, or utilization of hypotensive drugs). Multiple logistic regression analysis was used to evaluate the associations between anthropometric indexes and hypertension. The Receiver Operating Characteristic (ROC) curve analysis was used to evaluate sensitivity and specificity of BMI (≥ 30) and level 2 WC as predictive factors of hypertension, and to determine the best predictive cut-off points for hypertension.

Results: WC was associated with hypertension in both genders. Level 2 WC and BMI ≥ 30 kg/m² showed a low sensitivity in identifying hypertension. The best predictive cut-off points for hypertension coincided with level 1 WC (≥ 80 cm) and with BMI ≥ 25 kg/m² (overweight) for women, and were lower than the values of level 1 WC and of overweight for men.

Conclusion: Level 2 WC and BMI ≥ 30 kg/m² are not adequate to identify the groups at the highest risk of hypertension, since this risk rises with small increases in adiposity.

Key words: Waist circumference, body mass index, hypertension, prediction.

Obesity is defined as an excess body fat resulting from a chronic imbalance between food intake and energy expenditure¹. Among the harmful effects of obesity we can point out the fact that it is an independent risk factor for the development of cardiovascular diseases and some types of cancer. Obesity is also strongly associated with other cardiovascular risk factors (hypertension, diabetes, and dyslipidemias), thus increasing cardiovascular morbidity and mortality¹⁻⁴.

For the diagnosis of obesity, there are several indirect methods able to precisely estimate the total amount of body fat as well as its distribution. Among these methods we can point out computed tomography, dual-energy X-ray absorptiometry (DEXA), and magnetic resonance imaging. However, when simplicity and costs of the several methods are considered, the use of anthropometric indexes – body mass index (BMI), waist-hip ratio (WHR), or only waist circumference (WC) and skinfolds (SF)⁴ – has been recommended to conduct epidemiological studies.

Although BMI does not measure body composition, it is a potentially good indicator of the nutritional status in epidemiological studies. Its utilization is based on results of population studies showing that BMI is weakly correlated with height and strongly correlated with total fat mass, and on the association between high BMI and morbidity and mortality of

cardiovascular diseases, diabetes mellitus, colon cancer, and biliary diseases^{1,4,5,6}.

However, the relation between BMI and risk of morbidities may be affected by body fat distribution since the main complications of obesity, which include cardiovascular diseases, diabetes mellitus, hypertension and hyperlipidemia, are associated with a higher accumulation of abdominal fat, regardless of body weight^{7,8}.

The comparison of anthropometric measurements with diagnostic imaging tests such as magnetic resonance and computed tomography shows that waist circumference was the anthropometric variable that had the best correlation with visceral adipose tissue⁹. Thus, a more sensitive measurement to assess abdominal fat may be more useful than BMI in identifying risk factors associated with obesity.

The cut-off points currently used to classify WC were defined by Lean et al¹⁰ in a cross-sectional study with a sample of 904 men and 1,014 women between 25 and 74 years of age, in the population of North Glasgow. WC cut-off points associated with BMI 25 kg/m² and 30 kg/m² and/or with WHR ≥ 0.95 for men and ≥ 0.80 for women were identified. To facilitate their use both in the clinical practice and in health promotion programs these cut-off points were described as action levels: at action level 1 (WC ≥ 80 cm for women and

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WC \geq 94 cm for men), the individual has a higher risk of morbidities associated with obesity and should be advised to stop gaining weight and to adopt a healthy lifestyle; at level 2 (\geq 88 for women and \geq 102 for men), the individual has a very increased risk of morbidities associated with obesity and should seek urgent help from a health professional to lose weight and be assessed for other risk factors.

However, the universal use of these cut-off points is questioned, since their sensitivity in identifying risk factors associated with obesity may vary among the different populations and age groups¹¹⁻¹⁴.

The possibility of use of a measurement that is simple, inexpensive, easy to interpret, and mainly, that can be performed by individuals themselves as a form of screening in health promotion and cardiovascular risk-factor prevention programs, encouraged the carrying out of this study, whose purposes were to assess the association between the anthropometric indexes – BMI and WC – and hypertension, their general predictive ability, the performance of the cut-off points recommended, and the best predictive cut-off points of these anthropometric indexes for the identification of the risk of hypertension in the adult population of the city of Goiânia.

Methods

Study design - This study was developed using data from the *Estudo da Prevalência e do Conhecimento da Hipertensão Arterial e alguns Fatores de Risco em uma Região do Brasil* (Study of the Prevalence and Knowledge of Hypertension and some Risk Factors in a Brazilian Region), a project approved and financed by *Conselho Nacional de Desenvolvimento Científico e Tecnológico – CNPq* (National Council for Scientific and Technological Development – CNPq). This is a cross-sectional population study conducted in the capitals and in two cities in the interior of the States of Goiás and Mato Grosso. In the present study only the data collected from June, 2001 to December, 2001 regarding Goiânia were analyzed.

The sample size for the city of Goiânia was calculated considering a population of 1,004,098 inhabitants¹⁵, the prevalence of hypertension in Brazil (20% of the adult population)¹⁶, a 95% confidence interval and an estimation error of 10%. Thirty per cent were added to the sample obtained ($n = 1,534$) to compensate the losses ($n = 1,994$). The sample effectively studied consisted of 1,454 individuals older than eighteen years of age, of both genders, not institutionalized and residing in the urban area (72.9% of the total sample and 95% of the required sample).

The households were selected by clusters in two phases using probabilistic sampling. The first phase consisted of the identification, in the IBGE (*Instituto Brasileiro de Geografia e Estatística* – Brazilian Institute of Geography and Statistics), of the census sectors used in the 1998 National Household Sampling Survey (*Pesquisa Nacional por Amostragem de Domicílios* – PNAD) in the urban zone of the city of Goiânia. The second phase consisted of the selection of households. For this selection, the number of households in each sector and the total size of the sample were considered. Based on the calculation of the sample size by sector, the households of each sector were randomly and systematically raffled out.

In the households selected only one resident chosen by lot among the residents over eighteen years of age was interviewed to avoid problems of information interdependence between interviewees. Pregnant women and mothers of children under six months of age were excluded from the lot drawing to avoid errors in data interpretation. Hospitalized residents were also excluded.

In the original study, the sample from twenty to 64 years of age corresponded to 1,252 individuals, 433 men and 819 women. Of these, two men were excluded (the WC measurement of one of them was missing, and the other had a biologically implausible WC); thirteen women were also excluded (blood pressure measurement was missing for nine of them, and blood pressure and WC measurements were missing for four of them). Thus, the final sample of this study consisted of 1,237 individuals.

Data collection was performed by trained interviewers who filled out a standardized questionnaire including questions on social and demographic conditions, diet, physical activities, alcohol consumption, smoking, and use of hypotensive drugs, in addition to blood pressure, weight, height, and WC measurements. The interview was conducted after individuals had signed the written consent whose protocol was approved by the Ethics Committee on Human and Animal Medical Research of *Hospital das Clínicas da Universidade Federal de Goiás*.

Study variables - The anthropometric measurements were taken according to Lohman et al¹⁷ recommendations. The individuals were weighed and measured barefoot and in light clothing, with a Plessner® electronic scale, model Giant Lithium, with a 150-kg capacity and 100-g precision, and a portable stadiometer (Seca®), with a 0.1-cm precision.

BMI was calculated by dividing weight (kg) by square height (m). BMI values were classified in: < 18.5 kg/m² (low weight); 18.5 to 24.9 kg/m² (normal); 25 to 29.9 kg/m² (overweight); and ≥ 30 kg/m² (obesity, named total obesity in the present article)⁴.

WC measurement was taken using a non-extensible tape measure at the natural waist level, average point between the anterior superior iliac crest and the last rib, with a 0.1-cm precision. The accumulation of fat around the waist, or abdominal obesity, was classified in two levels. Level 1 corresponded to WC values between 80.0 and 87.9 cm for women, and between 94.0 and 101.9 cm for men; level 2 corresponded to a WC ≥ 88.0 cm and ≥ 102.0 cm for women and men, respectively. Values below 80.0 cm for women and 94.0 cm for men were classified as adequate⁴.

For blood pressure measurement (BP) a semi-automatic monitor was used (OMRON – HEM 705 CP). This monitor was chosen because it minimizes the influence of the interviewer on blood pressure reading, and because it has already been validated¹⁸, and also its data are comparable to those obtained with a mercury column (reference standard). Blood pressure was measured twice, at a minimum interval of 5 minutes. The measurement was taken on the left arm following the recommendations proposed by the National Program of Hypertension Control. For analysis purposes, the second measurement was considered. Individuals were considered hypertensive when the systolic blood pressure (SBP) was \geq

140 mmHg and/or the diastolic blood pressure (DBP) was \geq 90 mmHg, or when they were taking hypotensive drugs¹⁹.

Control variables used were gender, age (in full years: 20-24; 25-34; 35-44; 45-54; 55-64), parity (total number of children of each woman interviewed), educational level (years of schooling: 0-3 years, 4-8 years, and \geq 9 years); per capita monthly family income (expressed in quartiles); smoking (smoker, former smoker, and never smoked); consumption of alcoholic beverages in the past week (categorized according to daily intake of ethanol in grams: $<$ 30 g or \geq 30 g for men, and $<$ 15 g or \geq 15 g for women), and performance of physical activities during leisure time.

Physical activity during free or leisure time was classified in four categories of level of effort: (1) sedentary – no physical activity, only activities such as reading and watching television; (2) light – occasional physical activities, such as walking, bicycle riding, and performing light exercises; (3) moderate – regular physical activity (running, gymnastics, swimming, team games); (4) intense – heavy training several times a week or regular participation in sports competitions. Because of the small number of individuals in the latter category, the third and fourth categories were grouped together.

Statistical analysis - After revision of the questionnaires, data were double-keyed for quality assessment of data keying. For the analysis, STATA (version 7.0)²⁰ was used.

The analyses were performed separately for men and women. Means and 95% confidence intervals of the variables studied were presented. A trend test was performed to assess the prevalence of hypertension in BMI and WC categories.

BMI and WC were tested separately in logistic regression models adjusted for age, educational level, income, smoking, parity (in women), alcohol consumption, and physical activities during leisure time. Because of the high colinearity between BMI and WC these measurements were not considered as independent variables in the same regression model having hypertension as the endpoint.

Receiver Operating Characteristic (ROC) Curve analyses were used to assess and compare the ability of identifying hypertension using the anthropometric indexes BMI and WC. The areas under the ROC curve provide the global probability of these indexes to correctly classify the presence or the absence of hypertension. An optimal test has an area

under the ROC curve equal to 1.0 whereas an area equal to 0.5 means that the test performance is not better than what is achieved at random²¹.

The sensitivity and specificity of level 2 WC (\geq 88 cm and \geq 102 cm for women and men, respectively) and of BMI \geq 30 kg/m² in identifying hypertension were calculated. Sensitivity was defined as the proportion of hypertensive individuals correctly identified, and specificity was defined as the proportion of normotensive individuals correctly identified. The best predictive WC and BMI cut-off points for hypertension – the point where sensitivity and specificity curves meet²², were also identified.

The statistical analyses were corrected by complex sample design using STATA's SVY commands, which consider the complex structure of the sample using the weights associated to each sample cluster and the effect of the sample design. In all tests a 5% significance level was used.

Results

Characteristics of the population studied are shown in Table 1. Mean weight, height, WC, SBP, and DBP were higher in men than in women; mean age and BMI were similar.

The prevalence of total obesity (BMI \geq 30 kg/m²) and abdominal obesity (level II WC) were 10.6% and 9.3% for men, and 13.7% and 19.6% for women, respectively.

There was a significant increase in the prevalence of hypertension with the increase in WC for the total of males. However, for females regardless of age bracket, the prevalence of hypertension increased both with the increase in BMI, and with the increase in WC (Tab. 2).

The multiple logistic regression analysis showed that the odds ratio for hypertension was approximately twice as high for men with high values of WC (\geq 94 cm and \geq 102 cm), when compared to the reference category ($<$ 94 cm). High BMI was not associated with hypertension when adjusted by control variables. However, the magnitude of the association for a BMI \geq 30 kg/m² was close to the values observed for level 1 and level 2 WC. For women, high values of BMI and WC were associated with hypertension in the adjusted models, and women with a WC \geq 88 cm had an approximately three-fold increase in odds ratio, and those with a BMI \geq 30 kg/m² had a 4.7-fold increase in comparison with the reference categories

Variables	Men (n = 431)		Women (n = 806)	
	Mean	CI (95%)	Mean	CI (95%)
Age (years)	38.7	(37.3; 39.5)	38.1	(37.1; 39.1)
Weight (kg)	70.7	(68.0; 73.3)	61.2	(60.0; 62.4)
Height (m)	169.6	(168.8; 170.4)	157.4	(156.8; 157.9)
BMI (kg/m ²)	24.6	(23.8; 25.3)	24.7	(24.3; 25.2)
WC (cm)	86.3	(84.0; 88.6)	78.6	(77.7; 79.5)
SBP (mmHg)	129.9	(126.1; 132.9)	117.5	(115.6; 119.4)
DBP (mmHg)	86.3	(84.0; 88.5)	79.0	(77.5; 80.5)

Table 1 – Means and 95% confidence intervals of the main variables, according to gender. Goiânia, Brazil, 2001

Original Article

Hypertension (%)

Variables	Men			Women		
	Total (n = 431)	Age bracket		Total (n = 806)	Age bracket	
		20-39 (n = 239)	40-64 (n = 192)		20-39 (n = 444)	40-64 (n = 362)
BMI						
< 25	38.4	34.6	46.1	17.4	11.5	30.2
25 – 29,9	35.9	35.7	36.0	39.0	19.4	56.2
≥ 30	58.5	54.0	61.9	58.4	44.7	66.1
	p* = 0.06	p* = 0.50	p* = 0.39	p* < 0.01	p* < 0.01	p* < 0.01
WC						
Adequate	34.8	33.0	38.0	17.3	11.3	32.3
Level 1	53.8	53.3	54.2	41.2	21.7	56.0
Level 2	54.2	59.2	51.9	50.3	37.2	57.5
	p* < 0.01	p* = 0.07	p* = 0.12	p* < 0.01	p* < 0.01	p* < 0.01
Total	39.7	36.2	44.3	29.4	16.2	47.3

* p-value for the trend test.

Table 2 - Prevalence (%) of hypertension according to BMI and WC classification in men and women by age bracket. Goiânia, Brazil, 2001

Variables	n	Crude OR	95% CI	AdjustedOR1	95% CI
Men					
Body mass index					
< 25 kg/m ²	223	1.00	-	1.00	-
25 to 29 kg/m ²	144	0.90	(0.52 ; 1.57)	0.66	(0.33 ; 1.32)
≥ 30 kg/m ²	54	2.26	(1.02 ; 4.79)	1.78	(0.89 ; 3.58)
		p* = 0.11		p* = 0.53	
Waist circumference					
< 94 cm	312	1.00	-	1.00	-
94 to 102 cm	73	2.18	(1.34 ; 3.54)	2.00	(1.04 ; 3.87)
≥ 102 cm	46	2.14	(1.07 ; 4.28)	1.87	(0.99 ; 3.62)
		p* < 0.01		p* = 0.02	
Women					
Body mass index					
< 25 kg/m ²	451	1.00	-	1.00	-
25 to 29 kg/m ²	233	3.04	(2.17 ; 4.25)	2.51	(1.61 ; 3.90)
≥ 30 kg/m ²	122	6.67	(4.39 ; 10.14)	4.67	(3.21 ; 6.78)
		p* < 0.01		p* < 0.01	
Waist circumference					
< 80 cm	455	1.00	-	1.00	-
80 to 87cm	180	3.34	(1.71 ; 6.53)	2.47	(1.39 ; 4.80)
≥ 88 cm	171	4.84	(3.15 ; 7.44)	3.02	(1.87 ; 4.87)
		p* < 0.01		p* < 0.01	

¹Adjusted by age, educational level, income, smoking, alcohol consumption, physical activity during leisure time, and parity (females), *p of trend.

Table 3 - Crude and adjusted odds ratio (OR) for hypertension according to body mass index and waist circumference by gender. Goiânia, Brazil, 2001

(Tab. 3). In these models, age interactions with both total obesity and abdominal obesity were tested, and they were not statistically significant.

In predicting hypertension, the area under the ROC curve for BMI was 0.71 (0.67; 0.75) for women and 0.57 (0.52; 0.63) for men. For WC, the area under the ROC curve was 0.71 (0.67; 0.75) for women, and 0.58 (0.52; 0.64) for men. These values show that WC and BMI have similar probabilities to correctly classify the presence or the absence of hypertension

in both genders; this ability is slightly higher among women.

Level 2 WC and BMI $\geq 30 \text{ kg/m}^2$ showed a low sensitivity in predicting hypertension, and the highest values were observed for men and women between forty and 65 years of age. Specificity was high for both genders (Tab. 4).

The best predictive WC and BMI cut-off points for hypertension are shown in Figure 1 and Table 5. At these cut-off points, sensitivity and specificity values are similar because they correspond to the point where sensitivity and specificity curves meet. For males, these points were 86 cm for WC, and 24.6 kg/m^2 for BMI, whereas for females they were 80 cm for WC and 25.0 kg/m^2 for BMI. These values varied with age, and were lower for individuals between twenty and 39 years of age, and higher for individuals between forty and 65 years of age.

Discussion

This study analyzed the association between obesity assessed by the anthropometric indexes – BMI and WC – and hypertension, and examined the predictive ability of these indexes to identify the risk of hypertension in the adult population of the city of Goiânia. The external and internal validity of this study were ensured by using a representative sample of the adult population of Goiânia, with information collected in the households by trained personnel, with standardized questionnaire and instruments, and by considering the effect of the complex sample design in the analyses. It is important to point out that, although 72.9% of the total sample had been effectively assessed, the comparison of the distribution of the population studied by age group and educational level with data from the 2000 demographic census¹⁵ did not show significant differences for both genders, which supports the hypothesis that the sample studied is representative of the adult population of Goiânia.

The major limitation of this study was its cross-sectional design, which does not allow the identification of the precedence in time between exposure and endpoint. Another limitation was the fact that the assessment of the cut-off points of the anthropometric indexes was performed exclusively in relation to hypertension. Other diseases associated

Variables	Sensitivity	Specificity
Men		
Body mass index		
20-39 years	10.3 (4.8; 18.7)	95.0 (89.9; 97.7)
40-65 years	21.1 (13.1; 31.4)	89.4 (82.4; 94.8)
Total	15.6 (10.7; 22.1)	92.7 (88.8; 95.5)
Waist circumference		
20-39 years	5.6 (2.0; 12.9)	97.8 (94.3; 99.6)
40-65 years	19.5 (12.1; 30.1)	85.8 (77.9; 91.9)
Total	12.5 (7.8 ; 18.2)	92.8 (88.8; 95.5)
Women		
Body mass index		
20-39 years	23.7 (14.4; 35.1)	94.3 (91.5; 96.5)
40-65 years	28.9 (22.0; 36.0)	86.7 (81.3; 91.3)
Total	27.2 (21.8; 33.6)	91.9 (89.4; 94.0)
Waist circumference		
20-39 years	27.6 (17.9; 39.6)	91.0 (87.8; 93.8)
40-65 years	36.3 (29.1; 43.9)	75.9 (69.2; 81.8)
Total	33.6 (28.0; 40.2)	86.2 (83.2; 89.0)

Table 4 - Predictive ability of total obesity (BMI $\geq 30 \text{ kg/m}^2$) and of level 2 waist circumference (WC) for the detection of risk of hypertension according to gender and age range. Goiânia, Brazil, 2001

Age range	n	WC		BMI	
		Cut-off point (cm)	S - E (%)	Cut-off point (kg/m^2)	S - E (%)
Men					
20-39 years	239	82	60.5	24.5	58.0
40-65 years	192	88	62.8	25.6	56.0
Total	431	86	60.4	24.6	59.2
Women					
20-39 years	444	76	62.8	23.5	59.5
40-65 years	362	83	63.2	25.6	66.5
Total	806	80	66.5	25.0	65.0

**The cut-off point where sensitivity equals specificity identifies the highest number of hypertensive and non-hypertensive individuals.*

Table 5 - WC and BMI cut-off points where sensitivity equals specificity (S - E)* in predicting hypertension according to age bracket in men and women. Goiânia, Brazil, 2001

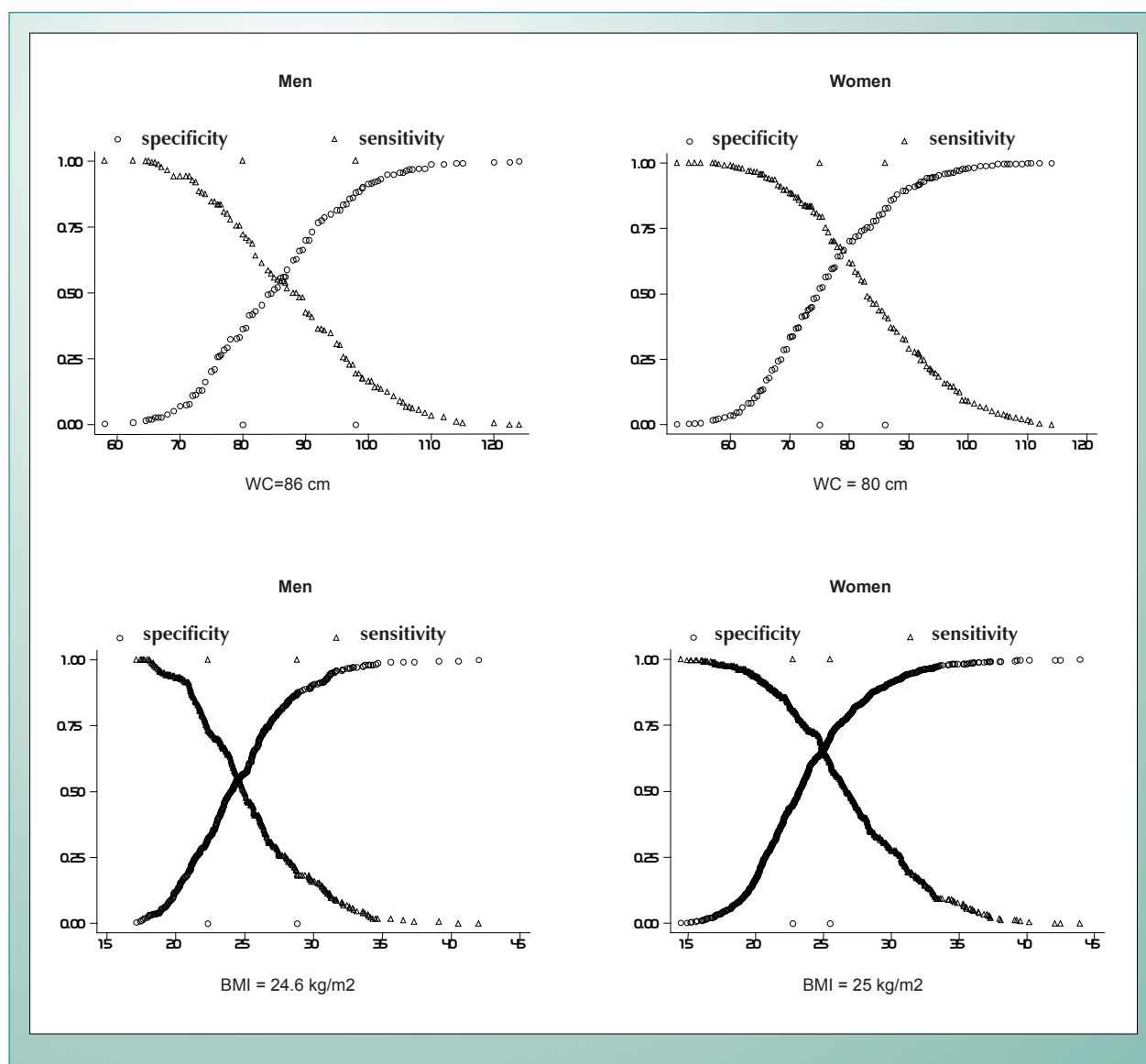


Fig. 1 - WC and BMI cut-off points where sensitivity equals specificity (S - E)* in predicting hypertension in men and women between twenty and 64 years of age. Goiânia, Brazil, 2001.

with obesity, such as dyslipidemia and diabetes, were not incorporated into this study.

Similar to other studies^{8,10,12}, a high correlation between WC and BMI was observed for both genders. However, for women, the prevalence of obesity varied according to the anthropometric index used, and central obesity assessed by the level 2 WC (≥ 88 cm for women, and ≥ 102 cm for men) was more prevalent than total obesity ($\text{BMI} \geq 30 \text{ kg/m}^2$). These data suggest a difference between genders in the diagnostic ability of the cut-off points recommended for WC.

Hypertension was observed both in individuals with a normal BMI and in obese individuals. Among the individuals with a normal BMI, 38.4% and 17.4% of men and women were hypertensive, respectively. Among the obese, the proportion of hypertensive individuals raised to 59.1% among men and 58.4% among women. The prevalences of hypertension in

the presence of abdominal obesity were close to the values observed for total obesity. According to observations of other studies^{23,24}, these results show that both weight gain and accumulation of abdominal fat increase the probability of an individual to become hypertensive.

In the multiple logistic regression analysis, level 1 and 2 WC were associated with the risk of hypertension in both genders. Overweight and total obesity, in turn, were associated with hypertension only in women. Although total obesity was not significantly associated with hypertension in men, the magnitude of the association was close to the values observed for WC, and the lack of statistical significance may have occurred because of the smaller sample size for men.

The excess adipose tissue is one of the major risk factors associated with hypertension both in prospective studies and in cross-sectional studies in several populations, regardless

of age²³⁻²⁶.

In prospective studies, medium and long-term weight gain increased significantly the incidence of hypertension, and weight loss reduced this incidence. Estimates of Framingham's study suggest that approximately 70% of the new cases of hypertension could be attributed to obesity or to weight gain¹. In the Nurses' Health Study, a 1 kg/m² increase in BMI was associated with a 12% increase in the risk of hypertension²⁷.

Cross-sectional population studies conducted in Brazil showed that in the city of Porto Alegre hypertension was equally associated with BMI, WHR, and WC in women, whereas in men only BMI was associated with hypertension²⁸. In the Nutrition and Health Research conducted in the city of Rio de Janeiro, the waist-hip ratio showed a higher ability to predict hypertension and a lower correlation with BMI than did WC²⁹. In a study conducted in São Paulo, the waist-hip ratio and WC were similarly associated with hypertension³⁰. In a sample of women from a health care center in the city of Belo Horizonte, WC was significantly associated with hypertension. However, the cut-off points assessed – 80 cm and 88 cm, showed moderate (63.8%) and low (42.8%) sensitivity for hypertension, respectively³¹.

In the single Brazilian longitudinal population study (5.6 ± 1.1-year follow-up) exploring the association between different obesity indexes and the incidence of hypertension, the risk ratio for level 2 WC was 1.78 (0.76; 4.09) for men, and 1.72 (1.09; 2.73) for women, whereas for BMI ≥ 30 kg/m² the risk ratio was 1.08 (0.52; 2.24) for men, and 1.74 (0.93; 3.26) for women. The conclusion was that the hypertension incidence risk was more consistent when obesity was defined using level 2 WC than using BMI ≥ 30 kg/m², for both genders³².

These studies corroborate the importance of excess total weight and of visceral fat accumulation in the prevalence of hypertension. However, the anthropometric indexes more frequently used in epidemiological studies (BMI, WC, and WHR) do not reflect the same amount of fat in different populations. The occurrence of differences in the relation between body fat and BMI and/or WC is already well established; this is partly due to genetic differences in body composition, as well as to differences in food intake and in the pattern of physical activity.

The cut-off points recommended for level 2 WC showed low sensitivity for both genders in identifying the risk of hypertension, which was also observed for BMI ≥ 30 kg/m². The high specificity observed provides the cut-off points used with an ability to classify few normotensive individuals as hypertensive; on the other hand, many hypertensive individuals are classified as normotensive because of low sensitivity.

In other studies, the sensitivity observed for these anthropometric indexes was low to moderate, and the differences both in the prevalence of risk factors and in body composition produce different sensitivities in the identification of hypertension in different populations. In Lean et al's study¹⁰,

the sensitivity of level 2 WC in predicting hypertension was 40.3% and 56.6% for adult men and women, respectively. In a sample of overweight American adults, the sensitivity of level 2 WC increased with age and was different among ethnic groups. For men between forty and 59 years of age, 32.0%, 53.8% and 35.0% sensitivities were observed for White, Black and Hispanic American, respectively¹³.

In the analysis of the ROC curve it was interesting to observe that, for the total of women, the best predictive cut-off points for risk of hypertension correspond to the values currently recommended for level 1 WC and for overweight – 80 cm and 25 kg/m², respectively. For men, the balance point between sensitivity and specificity curves was observed below the values currently recommended for level 1 WC and for overweight – 86 cm and 24.6 kg/m², respectively. These cut-off points were lower among the youngest individuals and higher for individuals above forty years of age for both genders. This corroborates the evidences that the relation between adiposity and hypertension is stronger among younger adults and that the risk for cardiovascular diseases is observed as of small increases in total or abdominal adiposity.

The universal use of WC and BMI has been questioned by several researchers, mainly for Asian populations^{11,33}. In a sub-sample of White men (n = 4,388) and women (n = 4,631) participating in the Third National Health and Nutrition Examination Survey (NHANES III) Zhu et al¹⁴ observed that a WC ≥ 90 cm (men) and ≥ 83 cm (women) have the same odds ratio for the cardiovascular risk factors associated with a BMI ≥ 25 kg/m², whereas a WC ≥ 100 cm and ≥ 93 cm for men and women, respectively, is equivalent to the odds ratio observed for BMI ≥ 30 kg/m².

The results of the present study show that for men the impact of abdominal obesity on hypertension was higher than that of total obesity; for women, both abdominal and total obesity were significantly associated with hypertension. The cut-off points for abdominal obesity – level 2, and for total obesity – BMI ≥ 30 kg/m² showed a low sensitivity in detecting hypertension for both genders. For men, the most adequate cut-off points for the screening of risk of hypertension were lower than the values recommended for level 1 WC (≥ 94 cm) and for the classification of overweight (≥ 25.0 kg/m²). For women, in turn, the cut-off points corresponded to the values recommended for level 1 WC (≥ 80 cm) and for the classification of overweight (≥ 25.0 kg/m²). These results corroborate the relevance of using these cut-off points as part of the strategies of public health programs both for the prevention and control of excess weight and to warn about the need to evaluate the presence of hypertension as well as of other risk factors associated with weight gain.

Potencial Conflict of Interest

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

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