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Original

Sagital abdominal diameter, but not waist circumference is strongly associated with glycemia, triacilglycerols and HDL-c levels in overweight adults

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Abstract

Aim: **To correlate the sagittal abdominal diameter (SAD) and waist circumference (WC) with metabolic syndrome-associated abnormalities in adults.**

Methods: **This cross-sectional study included one-hundred twelve adults (M = 27, F = 85) aging 54.0 ± 11.2 yrs and average body mass index (BMI) of 30.5 ± 9.0 kg/m². The assessment included blood pressure, plasma and anthropometric measurements.**

Results: **In both men and female, SAD and WC were associated positively with body fat% (r = 0.53 *vs* r = 0.55), uric acid (r = 0.45 *vs* r = 0.45), us-PCR (r = 0.50 *vs* r = 0.44), insulin (r = 0.89 *vs* r = 0.75), insulin resistance HOMA-IR (r = 0.86 *vs* r = 0.65), LDL-ox (r = 0.51 *vs* r = 0.28), GGT (r = 0.70 *vs* r = 0.61), and diastolic blood pressure (r = 0.35 *vs* r = 0.33), and negatively with insulin sensibility QUICKI (r = -0.89 *vs* r = -0.82) and total cholesterol/TG ratio (r = -0.40 *vs* r = -0.22). Glycemia, TG, and HDL-c were associated significantly only with SAD (r = 0.31; r = 39, r = -0.43, respectively).**

Conclusion: **Though the SAD and WC were associated with numerous metabolic abnormalities, only SAD correlated with dyslipidemia (TG and HDL-c) and hyperglycemia (glycemia).**

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Key words: *Sagital abdominal diameter. Waist circumference. Hyperglycemia. Dyslipidemia. Inflammation. Anthropometric measurements.*

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DIÁMETRO ABDOMINAL SAGITAL, PERO NO LA CIRCUNFERENCIA DE LA CINTURA SE ASOCIA FUERTEMENTE CON LA GLUCEMIA, TRIACILGLYCEROLS Y HDL-C EN ADULTOS CON SOBREPESO

Resumen

Objetivo: **Correlacionar el diámetro abdominal sagital (DAS) y la circunferencia de la cintura (CC) con las anomalías asociadas al síndrome metabólico en adultos.**

Métodos: **Este estudio transversal incluyó a 112 adultos (H = 27, M = 85) con edad de 54,0 ± 11,2 años y un promedio de índice de masa corporal (IMC) de 30,5 ± 9,0 kg/m². La evaluación incluía la presión sanguínea y medidas plasmáticas y antropométricas.**

Resultados: **Tanto en hombres como mujeres, DAS y CC se asociaban positivamente con el % grasa corporal (r = 0,53 *vs* r = 0,55), el ácido úrico (r = 0,45 *vs* r = 0,45), la us-PCR (r = 0,50 *vs* r = 0,44), la insulina (r = 0,89 *vs* r = 0,75), la resistencia a la insulina HOMA-IR (r = 0,86 *vs* r = 0,65), la LDL-ox (r = 0,51 *vs* r = 0,28), GGT (r = 0,70 *vs* r = 0,61), y la presión sanguínea diastólica (r = 0,35 *vs* r = 0,33), y negativamente con la sensibilidad a la insulina QUICKI (r = -0,89 *vs* r = -0,82) y el cociente colesterol total/TG (r = -0,40 *vs* r = -0,22). La glucemia, los TG, y la HDL-c se asociaban significativamente sólo con DAS (r = 0,31; r = 0,39, r = -0,43, respectivamente).**

Conclusión: **Aunque DAS y CC se asociaban con numerosas anomalías metabólicas, sólo DAS se correlacionaba con la dislipemia (TG y HDL-c) y la hiperglucemia (glucemia).**

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Palabras clave: *Diámetro abominal sagital. Circunferencia de la cintura. Hiperglucemia. Dislipemia. Inflamación. Medidas antropométricas.*

Introduction

The ''gold standard'' measurements of visceral or intraabdominal obesity are obtained by computed tomography, dual-energy-X ray absorptiometry, or magnetic resonance imaging. However, they are expensive and dual-energy-X ray absorptiometry and computed tomography involves radiation exposure. Though, it is impractical for epidemiologic purposes, in the context of primary care, or in clinic routine.[1,2]

Indirect anthropometric estimates of body composition have proven usefulness for clinical practice and epidemiologic surveys because they are simple, noninvasive, and cheap. Several studies indicate that measures of abdominal fat are better predictors of metabolic syndrome (MS) and inflammation than total body adiposity as assessed by body mass index (BMI) in adults.[3-7]

In adult populations, the waist circumference (WC) is the most commonly used indicator of abdominal adiposity and is the main pathological finding in MS.[8,9] However, the reliability of this measure in people with subcutaneous fat has been questioned[10] because these individuals appear "tummy apron".

Sagittal abdominal diameter (SAD) is highly correlated with visceral adipose tissue assessment by computed tomography.[11] Methodologically the SAD would be better measurement than the WC, because the sliding of subcutaneous fat to the waist sides when the measurement is taken orthostatically.[3-5,12]

The aim of this study was to correlate two anthropometric measurements (WC and SAD) with MS-associated abnormalities in adults.

Materials and methods

Subjects and methods

This descriptive and cross-sectional study was conducted in patients clinically selected for lifestyle modification program "Mexa-se Pro-Saúde" (2006-2008). One hundred twelve patients (85 female and 27 male) participated of study. The criterion for exclusion was only subjects with liver, kidney, heart, or peripheral vascular disease, as well as chronic alcoholic.

This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects were approved by the Ethics Committee of Sao Paulo State University (UNESP, Brazil) nº 170/2005. Written informed consent was obtained from all subjects.

Anthropometric measurements

Height was measured to nearest 0.5 cm. Body weight was measured to the nearest 0.1 kg without shoes in light indoor clothing. BMI was calculated as the ratio of body weight (kg) divided by height (m) squared. WC was measured in a supine position between the lowest rib and the iliac crest.[13]

Body fat percentage (%BF) was calculated from the resistance value (ohms) informed by bioelectric impedance analysis (BIA) (Biodynamics® 450 model) and subsequent application in the equation recommended by Segal et al.[14] In order to reduce possible changes in water status, the participants were demanded to follow the recommendations: of avoiding drinking alcoholic beverages as well as caffeine for 24 hours before the test, fasting for 4 hours before the test, avoid intense exercising for at least 12 hours before the test, and let know about the use of medicine based on diuretics (in this case, the participants were not submitted to the test).[13]

The SAD was measured with a portable, sliding beam, abdominal caliper (Holtain, Ltd.; Dyfed, Wales, UK). The caliper's upper arm was brought down to just above an abdominal mark made midway between the iliac crests, a location that approximates to the L4-L5 interspace. The subject was asked to inhale and exhale gently, and the arm of the caliper was brought down to touch the abdominal mark without compression.[3]

Clinical and biochemical measurements

Blood pressure was measured in the participant's right arm after a 5 minutes rest by using an indirect auscultation with a mercury sphygmomanometer. Systolic and diastolic blood pressure was defined as Korotkoff phases 1 and 5, respectively.

Blood samples were drawn from an antecubital vein, and all serum and plasma samples were immediately chilled, kept on ice, centrifuged, and stored at -80°C until analyzed. Fasting glucose, total cholesterol, high-density lipoprotein (HDL-c), triacilglycerols (TG), γ-glutamyl transferase (GGT) and uric acid were quantified by commercial kits by enzymatic colorimetry assay (Labtest Diagnostica, MG, Brazil) in a semi-automatic spectrophotometry. Low-density lipoprotein (LDL-c) was calculated by the equation LDL-c = total cholesterol-(HDLc-TG/5)[15] and LDL-c subclass by the equation (TG/HDL-c ratio)[16] which is a good predictive factor for oxidized-LDL-c. Fasting insulin was assayed by immunochemical luminescence using commercial kits (DPC Medlab) in automated equipment (Immulite 2000R; DPC Medlab). The insulin resistance was calculated by the Homeostasis Model Assessment of insulin resistance (HOMA-IR) and for insulin sensitivity the QUICKI formula.[17]

Plasma by ultra-sensitivity C-reactive protein (us-CRP) was measured using Immulite Kit (DPCâ Medlab-Diagnostic Products Corporation, Los Angeles, CA).

Statistical analysis

Data are presented as means and standard deviations. The normality of the distribution within each sex

Table I
Characteristics of the study population

Variables	*Men (n = 27)*	*Female (n = 85)*	*p value*
Age (years)	53.2 ± 9.6	53.8 ± 10.4	0.82
Body mass index (kg/m^2)	31.3 ± 5.9	29.5 ± 6.0	0.28
Waist circumference (cm)	100.9 ± 14.6	95.7 ± 13.8	0.17
Sagittal abdominal diameter (cm)	23.7 ± 3.0	22.0 ± 4.0	0.14
Body fat (%)	33.5 ± 6.6	34.0 ± 7.4	0.85
Fasting glycemia (mg/dL)	111.0 ± 39.6	97.6 ± 37.2	0.25
Total cholesterol (mg)	194.5 ± 33.7	198.5 ± 36.3	0.83
HDL-cholesterol (mg)	49.2 ± 9.7	52.3 ± 11.5	0.39
LDL-cholesterol (mg)	119.6 ± 30.7	125.7 ± 34.0	0.59
Oxidized-LDL-c	3.7 ± 2.0	2.9 ± 2.4	0.30
Triacilglycerols (mg)	176.2 ± 65.5	147.8 ± 69.8	0.21
Total cholesterol/triglycerides ratio	1.4 ± 0.7	1.8 ± 0.9	0.22
Uric acid (mg/dL)	6.1 ± 1.8	4.5 ± 1.2	0.002*
C-reactive protein (mg/L)	0.45 ± 0.20	0.65 ± 0.84	0.47
Fasting insulin (ng/mL)	9.1 ± 4.6	9.5 ± 8.8	0.96
HOMA-IR	1.3 (0.3-6.8)	4.5 (1.4-20.0)	0.83
QUICKI	0.15 ± 0.02	0.15 ± 0.03	0.48
γ-glutamyl transferase (U/l)	31.5 ± 20.5	26.7 ± 13.5	0.64
Sistolic blood pressure (mmHg)	122.6 ± 19.3	122.7 ± 14.5	0.97
Diastolic blood pressure (mmHg)	73.3 ± 10.5	77.0 ± 10.6	0.39

Data are presented as means and standard deviations. HOMA-IR: Homeostasis model assessment for insulin resistance.
*p < 0.05 *vs* men.

group was tested for all the variables using the Kolmogorov-Smirnov test. Pearson's correlations were used to verify a possible association between WC and SAD with metabolic abnormalities and comparisons between sexes were performed with *Student's* unpaired t test. All statistical analyses were performed by using SPSS for Windows (version 12.0; SPSS Inc, Chicago, IL). P < 0.05 was considered as statistically significant.

Results

Participants showed an age averaging (mean±Sd) 54.0 ± 11.2 years, BMI of 30.5 ± 9.0 kg/m^2, SAD of 22.4 ± 3.9 cm (23.7 ± 3.0 cm for male and 22.0 ± 4.0 cm for female, p = 0.14), and WC of 96.3 ± 13.7 cm (101.0 ± 14.8 cm for male and 95.4 ± 13.4 cm for female, p = 0.17) (table I). Uric acid was the only measure that differed between genders. Other general characteristics of subjects studied are shown in table I.

SAD and WC were associated positively (fig. 1) with body fat% (r = 0.53 *vs* r = 0.55), uric acid (r = 0.45 *vs* r = 0.45), us-PCR (r = 0.50 *vs* r = 0.44), insulin (r = 0.89 *vs* r = 0.75), HOMA-IR (r = 0.86 *vs* r = 0.65), oxidized-LDL-c (r = 0.51 *vs* r = 0.28), GGT (r = 0.70 *vs* r = 0.61), and diastolic blood pressure (r = 0.35 *vs* r = 0.33), and negatively (fig. 1) with insulin sensibility QUICKI (r = -0.89 *vs* r = -0.82) and total cholesterol/TG ratio (r = -0.40 *vs* r = -0.22). Glycemia, TG, and HDL-c were associated significantly only with SAD (r = 0.31; r = 0.39, r = -0.43, respectively).Total cholesterol and LDL-c were not associated with neither adiposity indicators.

Discussion

The relative utility of several estimates of fat distribution has been controversial. Some investigators have proposed that WC is a better indicator of abdominal fat distribution than is waist-hip ratio, because it requires only one measurement and is more highly correlated with visceral fat[9,18] and yet is suggest that predictive equation for evaluation of abdominal obesity based on bioelectrical impedance may be very useful in the clinical practice.[19] SAD has been proposed to be even better than WC. However, no large or consistent difference between SAD and WC has been found in relation to visceral fat.[18] The present study and others[3-5,13] suggest that the SAD may be also a strong predictor of blood metabolic abnormalities.

Petersson et al.[5] demonstrated that every one-centimeter increase in SAD was associated with an increase of CRP by 0.41 mg/l, corresponding to an increased mean CRP level by 16%. This estimation is

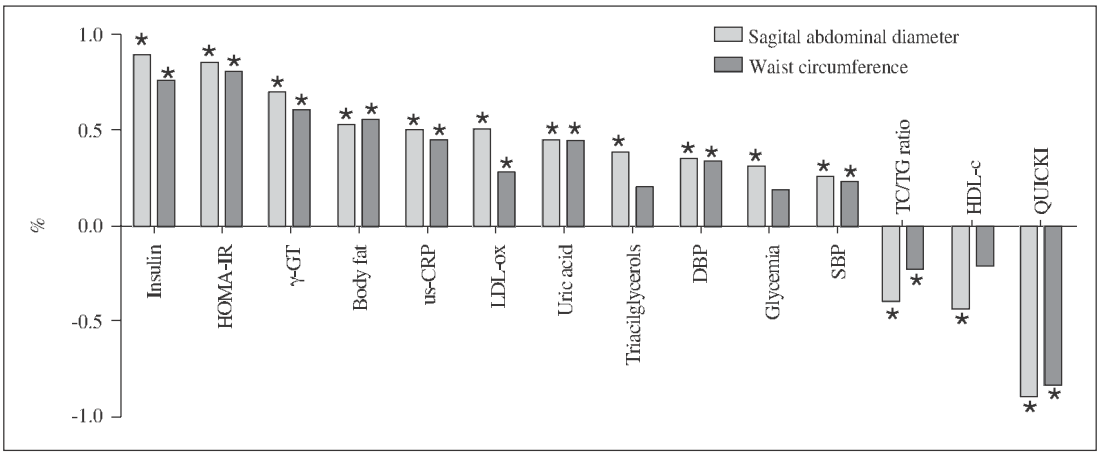

*Fig. 1.—Correlation coefficients between anthropometric measurements (SAD and WC) and metabolic components. HOMA-IR: Homeostasis model assessment for insulin resistance, γ-GT: γ-glutamyl transferase, us-CRP: ultra-sensitivity C-reactive protein, LDL-ox: low-density lipoprotein cholesterol oxidized, DBP: diastolic blood pressure, TC/TG ratio: total cholesterol/triglycerides, HDL-c: high-density lipoprotein cholesterol, QUICKI: quantitative insulin sensitivity check index. *p < 0.05.*

of clinical importance once elevated levels of serum CRP are associated with the MS and cardiovascular diseases.[20,21] Other studies have obtained a stronger association for SAD to insulin resistance,[22] cardiovascular risk[4] and MS[22] than WC, BMI and waist-hip ratio.

In a previous study[23] we established the cut-off points for SAD that corresponded to altered WC (WC > 102 cm for men and > 88 cm for women). The established points were 23.1 cm for men and 20.1 cm for women. Here we showed that either WC or SAD correlated well with plasma markers of metabolic abnormalities.

Recently, López de la Torre[24] demonstrated that both female and male and adults and elderly with high WC values are associated with diabetes. However, in the present study only SAD correlated with the MS components (TG, glycemia and HDL-c). Thus, the SAD could be seeing as an appropriate method to be used for MS diagnosis purpose.

In summary, this study shown that both SAD and WC associated with numerous metabolic abnormalities. However, only SAD correlated with glycemia, TG and HDL-c, indicating that the SAD is a strong indicator of dyslipidemia and hyperglycemia. Thus, we suggesting that SAD measurement should be adopt in clinical practice and epidemiological studies.

Author contributions

The work presented here was carried out in collaboration between all authors. GDP and RCB defined the research theme. GDP, KCPM, MMT and RCB designed methods and experiments. GDP wrote the manuscript, analyzed the data and interpreted the results. FM performed the plasma biochemistry analysis. All authors have given final approval of submitted version.

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