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Original

Waist circumference is better associated with high density lipoprotein (HDL-c) than with body mass index (BMI) in adults with metabolic syndrome

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Abstract

Background: **The measurement of waist circumference (WC) is the most prevalent cause of the metabolic syndrome (MS).**

Objective: **The aim of this study was to correlate WC and BMI with high-density lipoprotein (HDL-c) levels in patients with MS being consulted by the Family Health Program (PSF), Brazil.**

Methods: **This cross-sectional study was conducted from September to November 2008 with 42 patients (29 women and 13 men) from 35 to 77 years. Dietary intake was reported, and biochemical and body composition measures were taken.**

Results: **The HDL-c levels were higher in women when compared to men (48.4 ± 8.1 mg/dL *vs.* 36.4 ± 7.8 mg/dL). However, the triglycerides (TG)/HDL-c ratio and TG concentrations were lower in women (3.8 ± 1.5 and 178.0 ± 57.8 mg/dL, respectively) than in men (9.4 ± 8.5 and 471.5 ± 501.5 mg/dL, respectively). Regarding skinfold profile, the triceps was greater in females (37.0 ± 8.4 cm *vs.* 20.7 ± 10.5 cm). The dietetic profile showed that women had a lower intake of energy, fiber, phosphorus and sodium. The fruits and vegetables intake was diminished in the participants of this study, as less than 60% of the women and 50% of men met the daily recommendations. Approximately 54% of men and 28% of women had a lower intake of dairy products daily. Moreover, the results shows that the WC was negatively correlated to HDL-c ($r = -0.41$, $p < 0.05$) whereas the BMI is not associated with HDL-c ($r = -0.34$, $p > 0.06$).**

Conclusion: **Our findings showed that WC is a better predictor of changes in HDL-c than BMI.**

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Key words: *Waist circumference. Body mass index. Obesity. Metabolic syndrome. Food intake.*

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CIRCUNFERENCIA DE LA CINTURA ES MEJOR ASOCIADO CON LIPOPROTEÍNAS DE ALTA DENSIDAD (LAD-C) QUE CON EL ÍNDICE DE MASA CORPORAL (IMC) EN ADULTOS CON SÍNDROME METABÓLICO

Resumen

Antecedentes: **La medición de la circunferencia de la cintura (CC) es la causa más prevalente del síndrome metabólico (SM).**

Objetivo: **el propósito de este estudio fue correlacionar la CC y el IMC con las concentraciones de lipoproteínas de densidad elevada (HDL-c) en pacientes con SM vistos en consulta del Programa de salud familiar (PSF), de Brasil.**

Métodos: **Este estudio trasversal se realizó entre septiembre y noviembre de 2008 en 42 pacientes (29 mujeres y 13 hombres) de 35 a 77 años. Se registró la ingesta dietética y se tomaron medidas biomecánicas de la composición corporal.**

Resultados: **las concentraciones de HDL-c fueron significativamente mayores en las mujeres en comparación con los hombres (48,4 ± 8,1 mg/dl frente a 36,4 ± 7,8 mg/dl). Sin embargo, la relación triglicéridos (TG)/HDL-c y las concentraciones totales de TG (3,8 ± 1,5 mg/dl y 178,0 ± 57,8 mg/dl, respectivamente) fueron menores en las mujeres que en los hombres (9,4 ± 8,5 mg/dl y 471,5 (92,0-1793,5) mg/dl, respectivamente). Con respecto al perfil del pliegue cutáneo, el tríceps fue mayor en mujeres (37,0 ± 8,4 cm frente a 20,7 ± 10,5 cm). El perfil dietético mostró que las mujeres tenían un menor aporte de energía, fibra, fósforo y sodio. La ingestión de frutas y verduras fue baja en los participantes en el estudio, menor del 60 y del 50% de las recomendaciones diarias en mujeres y hombres, respectivamente. Aproximadamente, el 54% de lo hombres y el 28% de las mujeres no tomaba productos lácteos a diario. Además, los resultados muestran que la CC se correlaciona negativamente con la HDL-c ($r = -0,41$, $p < 0,05$) mientras que el IMC no se asocia con las HDL-c ($r = -0,34$, $p > 0,06$).**

Conclusión: **nuestros hallazgos mostraban que la CC es un mejor predictor de los cambios en las HDL-c que el IMC.**

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Palabras clave: *Circunferencia de la cintura. Índice de masa corporal. Obesidad. Síndrome metabólico. Ingestión de alimentos.*

Introduction

Metabolic Syndrome (MS) is defined by the Adult Treatment Panel III[1] as abdominal obesity (waist circumference-WC greater than 94 cm for men and 80 cm for women) combined with two or more of the following criteria: triglycerides greater than 150 mg/dL, HDL less than or equal to 40 mg/dL for men and 50 mg/dL for women, systolic blood pressure greater than or equal to 130 mmHg or diastolic blood pressure higher than or equal to 85 mmHg, fasting glucose greater than or equal to 100 mg/dL.

While a high body mass index (BMI) reflects general overweight and obesity, central adiposity is the factor most associated with increased risk for cardiovascular disease (CVD), hypertension, diabetes and dyslipidemia.[2,3]

Abdominal obesity is represented by an increase of abdominal fat and is considered by itself an important risk factor for chronic noncommunicable diseases, more than other forms of body fat distribution.[3] Furthermore, WC can be characterized as a better indicator of visceral adiposity and is strongly related to CVD.[2-5] Based on these findings, studies correlating WC and BMI with changes in the lipid profile of patients with MS are necessary, as this syndrome is highly prevalent worldwide. Thus, the aim of this study was to correlate WC and BMI with HDL-c levels in patients with MS being consulted by the Family Health Program (PSF), Brazil.

Methods

Subjects and methods

This cross-sectional study was conducted from September to November 2008 in patients screened clinically for nutritional counseling, attended by the Family Health Program (Program de Saúde da Familia - PSF) of Mogi das Cruzes, located in the Metropolitan Area of São Paulo, Brazil. The only criterion for inclusion was women and men with MS (defined by the ATP III),[6] but patients with liver, kidney or heart diseases were excluded, as were both women and men with chronic consumption of alcohol. As a whole, 42 patients (29 women and 13 men) from 35 to 77 years were evaluated. All the participants signed the prior informed consent designed according to the nº 196/96 on "Research involving human beings, from the Health Board of the Ministry of Health" approved by the Ethics Committee of Mogi das Cruzes University, under number 131/2008.

Anthropometry and body composition assessments

Body weight and height was measured using an electronic scale (Filizola®, São Paulo, SP, Brazil) and an calibrated stadiometer (Sanny®, Brazil), respectively. Both was measured according to the norms standard by Heyward and Stolarczyk,[7] followed by BMI calculation.[8]

WC was measured 2 cm over the umbilical scar[9] and the arm circumference was measured to evaluate the reduction of the muscle or fat mass caused by reduction of body weight. This was followed by evaluations of triceps and biceps skinfold thickness, measured at the midpoint of the upper arm and was expressed in mm by means of a Lange skinfold caliper in triplicate.[10]

Dietary measurements

Food habits were evaluated by 24 h recall questionnaire and food frequency questionnaire (FFQ). Nutritional analysis was carried out using the NutWin® (Federal University of São Paulo-UNIFESP, Brazil) software. Table of Food Composition-Brazil[11] and TACO version 2-Brazil[12] tables were used to determine the macro and micronutrients content of foods.

Biochemical measurements

Blood samples were obtained after a 12-hour fast and analyzed in the Hospital Laboratory of the city of Mogi das Cruzes, São Paulo, Brazil. Labtest® kits were used to assess fasting levels of blood glucose, total cholesterol, HDL-c and triglycerides. The samples were analyzed using an enzymatic method. LDL-c levels were calculated according to the Friedewald equation (LDL-c = total cholesterol-(HDL-c)-(TG/5)[13] and LDL-c subclass levels by the equation (TG/HDL-c ratio)[14] which is a good predictive factor for oxidized-LDL-c.

Statistical analysis

A Kolmogorov-Smirnov test was applied and showed that the data of this study were distributed normally. Thus, the variables were expressed by descriptive analysis (mean and standard deviation). The t-test was used to check possible differences between the sexes. Linear relationships were estimated using Pearson correlation to examine the associations of the WC and BMI with alterations in HDL-c. An level of $P \leq 0.05$ was considered significant. For all analyses was used the STATISTICA software, version 6.0.

Results

When analyzing table I, it is possible to notice significant differences between men and women in relation to anthropometric (except weight, BMI, WC, and biceps skinfold), blood and dietetic variables. Regarding skinfold variables, the triceps was greater in

Table I
Characteristics of the study population

Parameters	*Female (n = 29)* *Mean ± SD*	*Male (n = 13)* *Mean ± SD*	*p† value*
Age (years)	53.8 ± 9.3	56.7 ± 9.0	0.97
Weight (kg)	79.0 ± 15.0	84.9 ± 13.4	0.23
Body mass index (kg/m^2)	34.0 ± 6.2	31.1 ± 4.5	0.13
Waist circumference (cm)	106.8 ± 11.8	108.7 ± 11.7	0.71
Biceps skinfold (mm)	38.7 ± 13.7	35.2 ± 3.19	0.46
Triceps skinfold (mm)	37.0 ± 8.4	20.7 ±10.5	0.0001*
Glycemia (mg/dL)	126.4 ± 42.2	144.9 ± 38.8	0.24
Total cholesterol (mg/dL)	221.8 ± 55.8	214.1 ± 39.6	0.69
HDL-c (mg/dL)	48.4 ± 8.1	36.4 ± 7.8	0.0009*
LDL-c (mg/dL)	136.4 ± 52.1	131.6 ± 36.2	0.81
TG/HDL-c ratio	3.8 ± 1.5	9.4 ± 8.5	0.005*
Triglycerides (mg/dL)	178.0 ± 57.8	471.5 ± 501.51	0.008*
HbA1c	6.8 ± 1.1	7.5 ± 2.7	0.60
Calories (kcal)	1,260.0 ± 402.2	1,824.2 ± 1053.5	0.01*
Carbohydrate (%)	53.6 ± 12.2	51.8 ± 11.2	0.65
Protein (%)	20.0 ± 5.6	20.0 ± 7.2	0.98
Lipids (%)	26.3 ± 10.8	28.1 ± 10.7	0.61
Dietary fiber (%)	9.9 ± 4.6	15.1 ± 9.2	0.01*
Calcium (mg)	439.3 ± 240.0	438.9 ± 232.9	0.99
Phosphoro (mg)	738.1 ± 263.5	995.7 ± 501.5	0.03*
Sodium (mg)	2,013.7 ± 930.7	2,716.5 ± 982.0	0.04*
Magnesium (mg)	191.5 ± 88.4	208.1 ± 105.5	0.59
Potassium (mg)	2,193.7 ± 919.3	2,155.6 ± 982.0	0.90
Vitamin D (mg)	2.0 ± 1.0	8.4 ± 22.52	0.12
Cereals (servings)	3.0 ± 0.0	3.0 ± 0.0	0.57
Fruits (servings)	2.5 ± 0.7	2.4 ± 0.6	0.80
Vegetables (servings)	2.5 ± 0.5	2.2 ± 0.9	0.23
Milk (servings)	2.4 ± 1.0	2.3 ± 0.9	0.94
Meat (servings)	2.7 ± 0.4	2.9 ± 0.3	0.26
Beans (servings)	2.9 ± 0.2	3.0 ± 0.0	0.32
Oils (servings)	2.3 ± 1.0	2.0 ± 0.9	0.50
Sugars (servings)	1.8 ± 1.2	1.5 ± 1.2	0.48

*$p < 0.05$ *vs* female.

females (37.0 ± 8.4 cm *vs.* 20.7 ± 10.5 cm). The HDL-c levels were also higher in women (48.4 ± 8.1 mg/dL *vs.* 36.4 ± 7.8 mg/dL). However, the TG/HDL-c ratio and triglycerides concentrations (3.8 ± 1.5 mg/dL and 178.0 ± 57.8 mg/dL, respectively) were lower in women than in men (9.4 ± 8.5 mg/dL and 471.5 (92.0-1793.5) mg/dL, respectively). Regarding the dietetic profiles the women also had a lower energy, fiber, phosphorus and sodium intake (table I).

No significantly difference was observed in food group serving between genders (table I).

The fruits and vegetables intake was low in the participants of this study, as less than 60% of the women and 50% of the men met the daily recommendations. The daily frequency of dairy products was higher in women (72.4%) when compared to men (46.1%) (table II).

In order to identify which indicator of body composition that best identifies alterations in HDL-c levels, we found that WC was negatively correlated to HDL-c ($r = -0.41$, $p < 0.05$) whereas the BMI is not associated with HDL-c ($r = -0.34$, $p > 0.05$) (fig. 1).

Discussion

The energy intake reported by the patients (1,824 kcal for males and 1,259 kcal for females) was below the daily energy requirement. However, it should be noted that the calculation of energy requirement was performed using the current weight and not desirable weight, and with subtraction of 500 kcal. Certainly the values do not reflect the reality of habitual consumption, because a chronic energy restriction is sufficient for weight loss. Moreover, their energy intake reported suggests omission of food intake, probably caused by guilt feelings. Scagliusi & Junior[15] reported that assessments of food intake in obese patients, showed consistent under-reporting of food intake. These authors found that females under-reported their energy consumption more than men, due to the larger social and cultural pressures they are subjected to concerning maintaining healthy eating habits and slim body patterns. Such under-reported were also more common among women in this study, in which men reached

Table II
Food frequency of food groups in accordance to gender

Food groups	Male								Female							
	Daily		Weekly		Monthly		Never		Daily		Weekly		Monthly		Never	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Rice, bread, roots	13	100	0	0	0	0	0	0	29	100	0	0	0	0	0	0
Fruits	6	46.1	5	38.4	2	15.38	0	0	16	55.1	12	41.3	1	3.4	0	0
Vegetables	5	38.4	7	53.8	0	0	1	7,69	17	58.6	12	41.3	0	0	0	0
Dairy	6	46.1	6	46.1	0	0	1	7,69	21	72.4	4	13.7	1	3.4	3	10.3
Meats and eggs	12	92.3	1	7.6	0	0	0	0	23	79.3	6	20.6	0	0	0	0
Beans	13	100	0	0	0	0	0	0	27	93.1	2	6.9	0	0	0	0
Oils	5	38.4	6	46.1	1	7.6	1	7,69	18	62.0	7	24.1	1	3.4	3	10.3
Sugars	4	30.7	5	38.4	0	0	4	30,77	14	48.2	7	24.1	3	10.3	5	17.2

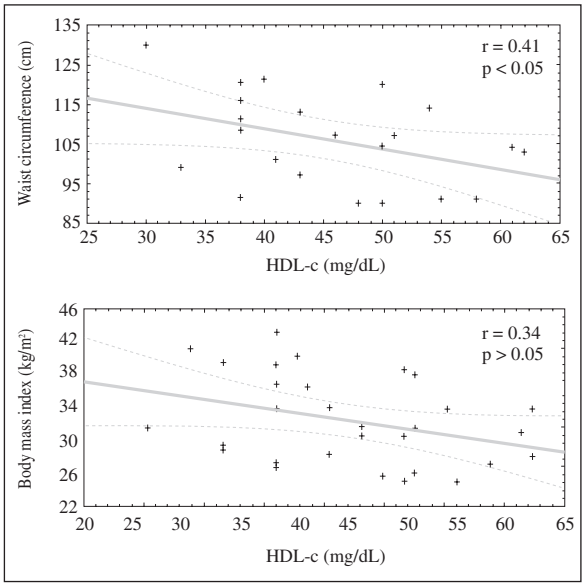

Fig. 1.—Relationship of HDL-c with indicators of body composition (BMI) and adiposity (WC) in both women and men with metabolic syndrome.

74.67% (± 42.85) and women 58.86% (± 19.56) of their energy requirement.

The consumption of fiber, calcium, magnesium and potassium in both genders did not reach 51% of the requirements by the Dietetics Requirements Intake (DRIs).[16] The minerals mentioned are related to low blood pressure as stated by Melanson,[17] and this was more prevalent in the study. Insufficient intake of vitamin D was also observed, which is related to increased risk of heart diseases, Diabetes Type I and II, cancer, especially colon cancer, as reported by Bandeira et al.[18]

Information obtained in this study regarding vitamin D, calcium, fiber and magnesium showed intake below the dietetics requirements, corroborating the study of Lichtenstein et al.[19]

As for sodium intake, in men this was exceeded by more than a factor of two and a factor of 1.5 in women compared to the DRIs, which may be related to the high prevalence of hypertension among patients in the study, which is consistent with the investigation carried out by Molina et al.[20] Fruits and vegetables were consumed daily by less than half of the subjects, which may be associated with low fiber intake in the volunteers of this study. The frequency of daily consumption of dairy products was also low. As demonstrated by Zemel[21] available evidence indicates that increasing dietary calcium intakes may result in reductions in fat mass as well as in blood pressure.

Most of the food groups are consumed more frequently daily, but the consumption of fruits and vegetables was unsatisfactory, because these foods should make up the daily diet of the whole population. In contrast it was found that the consumption of oils and fats, sugar and sweets were very high, which may be related to the much increased risk for CVD found in women, represented by excess visceral fat measured by WC compared to men. In a survey on household food availability, as described by Levy-Costa et al.,[22] the food groups most frequently consumed were oils, fats, sugars and sweets servings. In addition, the insufficient fruits and vegetables intake are related to the increase in chronic noncommunicable diseases, for e.g. obesity, dyslipidemia, and hypertension.

According to Maciel & Silva[23] the greater intake of fat and sugar are the major changes in eating habits over the past years. Excessive consumption of these nutrients is related to the development of obesity and other health complications.

Enes[24] also compares the increased intake of these nutrients with the observed decline in the consumption of legumes, fruits and vegetables, which are important sources of fiber.

Ferreira et al.[25] report that obesity and particularly abdominal fat has a major impact on CVD by associating with great frequency to dyslipidemia, hypertension, insulin resistance and diabetes that favor the occurrence of cardiovascular events, particularly in the coronary artery. Moreover, Brenner et al.[5] have been

showed that the WC is a stronger predictor of cardiometabolic health when compared with BMI.

Martins & Marine[26] reported that central obesity increases with age and is more frequent in women. The data in the figure 1 show that the higher WC, the lower the concentration of HDL-c, which is designed to carry cholesterol from tissues and the bloodstream into the liver for excretion, making it possible to correlate excess body fat to the risk CVD.

Souza et al.[27] states that weight reduction is associated with increased HDL-c and decreased triglycerides, corroborating the results presented in figure 1. Moreover, recently we have been demonstrated that short-term[28] and long-term[29] of nutritional counseling is effective to reduce BMI and WC in individuals with MS and impaired glucose tolerance, respectively.

In summary, our findings showed that WC is a better predictor of changes in HDL-c than BMI, and its use in clinical practice is essential for identifying changes in lipid profile, especially in adults with a predisposition to CVD.

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STA and BMM collected the data and wrote the manuscript. GDP performed the statistical analysis and wrote the manuscript. MERS participated in its design. MVS conceived the study, participated in its design and coordination. All authors read and approved the final manuscript.

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