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Association between LAP Index (lipid accumulation product) and metabolic profile in hospitalized patients

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Abstract

Introduction: **lipid Accumulation Product (LAP) Index correlates to cardiovascular risk factors in general population but it has not been tested in hospitalized patients.**

Objectives: **we aimed to evaluate associations between LAP Index and metabolic profile in a tertiary hospital.**

Methods: **Cross-sectional study with 90 inpatients. Lipid profile, fasting glucose, systolic and diastolic blood pressure measurements were obtained from electronic medical records. Weight, height and waist circumferences (WC) were assessed; Body Mass Index (BMI) and LAP Index were calculated. Data were expressed as mean ± standard deviation or percentage. Pearson's correlation and Multiple Linear Regression were used to assess the objectives.**

Results: **mean age of participants was 55.03 ± 14.86 years and 47.8% (n = 43) were men. After adjustment for sex, age and physic activity LAP Index (log-transformed) was significantly associated with HDL-cholesterol ($p < 0.001$), fasting glucose ($p = 0.02$), systolic blood pressure ($p = 0.03$) and a trend toward total cholesterol ($p = 0.07$).**

Conclusion: **There are independent association between LAP Index (log-transformed) and metabolic profile in hospitalized patients.**

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Key words: *Obesity. Abdominal. Inpatients. Biological Markers. Blood Pressure.*

ASOCIACIÓN ENTRE EL ÍNDICE DE PAL (EL PRODUCTO DE ACUMULACIÓN LIPÍDICA) Y EL PERFIL METABÓLICO EN PACIENTES HOSPITALIZADOS

Resumen

Introducción: **el índice PAL (Producto de Acumulación Lipídica) se correlaciona con factores de riesgo cardiovasculares en la población general, pero no ha sido probado en pacientes hospitalizados.**

Objetivos: **evaluar las asociaciones entre el índice PAL y el perfil metabólico en un hospital de tercer nivel.**

Métodos: **estudio transversal con 90 pacientes hospitalizados. Se obtuvieron de los registros médicos electrónicos el perfil lipídico, la glucosa en ayunas y las mediciones de la presión arterial sistólica y diastólica. Fueron evaluados el peso, la talla y la circunferencia de la cintura (CC); se calcularon el Índice de Masa Corporal (IMC) y el Índice de PAL. Los datos se expresan como media ± desviación estándar o porcentaje. Para evaluar los objetivos se utilizaron la correlación de Pearson y la regresión lineal múltiple.**

Resultados: **la edad promedio de los participantes fue de 55,03 ± 14,86 años y el 47,8% (n = 43) eran hombres. Después de ajustar por sexo, edad y actividad física, el índice PAL (transformado-log) se asoció significativamente con el HDL-colesterol ($p < 0,001$), la glucosa en ayunas (p=0,02), la presión arterial sistólica ($p = 0,03$) y una tendencia hacia el colesterol total ($p = 0,07$).**

Conclusión: **en los pacientes hospitalizados existe una asociación independiente entre el índice PAL (transformado-log) y el perfil metabólico.**

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Palabras clave: *Obesidad. Abdominales. Pacientes hospitalizados. Marcadores biológicos. Presión arterial.*

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Abbreviations

BMI: Body mass index.
CVD: Cardiovascular disease.
HDL: High density lipoprotein.
IPAQ: International Physical Activity Questionnaire.
LAP: Lipid Accumulation Product.
LDL: Low density lipoprotein.
T2DM: Type-2 diabetes mellitus.
TG: Serum triglycerides.
IR: Insulin resistance.
SPSS: Statistical Package for the Social Science.
WC: Waist circumference.

Introduction

Obesity is the fifth leading cause of worldwide mortality and it is a well-known risk factor for metabolic abnormalities such as dyslipidemia, insulin resistance, higher values of blood pressure and cardiovascular disease. Central obesity seems to be associated with a worse metabolic profile when compared to general obesity[1]. Abdominal fat is composed by subcutaneous and visceral adipose tissue; however, visceral fat is more strongly correlated with cardiovascular risk factors, metabolic and cardiovascular disease than subcutaneous fat[2].

Traditional anthropometric indicators as body mass index (BMI) and waist circumference (WC) do not distinguish visceral and subcutaneous fat. So, anthropometric indexes of easy applicability and low cost have been proposed as an alternative to imaging methods for visceral fat detection[3]. The Lipid Accumulation Product (LAP) is one of these indexes; it is based on a combination of two safe and inexpensive measurements, WC and serum triglycerides (TG)[4], which tend to rise with age suggesting an overaccumulation of lipids over time[5]. It is known that LAP values are strongly correlated with visceral fat[6].

Studies have shown that LAP Index is associated with metabolic syndrome[7], type-2 diabetes mellitus (T2DM)[8], hypertension[9] and cardiovascular disease[10]. In addition, LAP Index has been evaluated in general population[4,8-10] and also in individuals with higher risk for cardiovascular disease (CVD)[11], in women with polycystic ovary syndrome[12] and individuals with T2DM[13]. Most of these studies suggest that LAP is a better index to predict a worse metabolic profile and CVD when compared to other traditional anthropometric indexes[8,9,11].

To evaluate obesity seems crucial in the hospital setting. However, many inpatients are not able to walk and/or to verify measures as weight and height. WC, in this case, could be a good anthropometric indicator to assess obesity independently of BMI calculation. Despite the superiority of LAP in evaluating cardiovascular risk factors when compared to WC and BMI in many populations, it has not been tested in hospitalized patients. The aim of this study was to verify a possible association between LAP Index and metabolic profile among inpatients.

Methods

This cross-sectional study enrolled 90 subjects, aged 18 to 80 years without cardiovascular disease admitted in a tertiary hospital in Porto Alegre/Brazil. Patients with more than 24h of hospitalization, who do not have biochemical data available in their medical records, who had WC <60cm, TG > 15 mmol/L, BMI > 40 kg/m^2 or relevant chronic diseases (i.e. cancer, heart failure, AIDS) were excluded. The Ethics Committees of the Institute of Cardiology of Rio Grande do Sul (4656/11) and of Nossa Senhora da Conceição Hospital (11-159) approved the protocol, which was in accordance with the Declaration of Helsinki and all patients signed a consent term to participate.

Demographic data (age, sex and self-reported skin color) and information regarding education (years at school) and lifestyle characteristics [smoking, abusive alcohol consumption (≥ 30g for men and ≥ 15g for women)] were collected using a standardized questionnaire. IPAQ (International Physical Activity Questionnaire) short version was used to detect the levels of physical activity[14].

Weight (kg) was measured with patients in light clothes, barefoot, in a 100g scale (Cauduro®) and height was obtained with a Sunny® stadiometer with 0.1cm scale. BMI was calculated by the weight (kg)/height (m)^2. WC was obtained with a plastic, flexible, inelastic measuring tape in the middle point between the lower costal rib and the iliac crest in a perpendicular plane, with patient standing in both feet and with both arms hanging freely[15].

Serum lipids (total cholesterol, HDL-cholesterol, LDL-cholesterol and triglycerides) and fasting glucose were measured by colorimetric enzymatic method, at the certified laboratory by the Nossa Senhora da Conceição Hospital and its values were obtained from medical records. Measurements of systolic and diastolic blood pressure (SBP, DBP) were also collected from medical records, and the mean of the three first measures of the morning was used for analyses. LAP Index, in cm.mmol.l, was calculated for men [(WC (cm)-65) x TG (mmol)] and women [(WC (cm)-58) x TG (mmol)][4].

Statistical analyses were performed using SPSS (Statistical Package for the Social Science, version 17.0, IL, USA). Means ± SD and percentages were described and correlations were tested by Pearson's correlation test; non-parametric variables were log-transformed. We tested the potential relationship between LAP and metabolic profile using multiple linear regression models, with the adjustment for age, sex and physical activity. The statistical significance level was set at a two-tailed type I error of 0.05.

Results

A total of 43 men and 47 women were assessed, with an average of 55.03 ± 14.86 years and 78.9% whites;

14.4% were current smokers and 18.9% had abusive alcohol consumption. Prevalence of obesity according to BMI ≥30 kg/m^2 was 28.1%.

Table I shows the characteristics of the sample. In general, patients have a high prevalence of sedentarism and the levels of total cholesterol, LDL-cholesterol and BP were considered acceptable. However, subjects showed high levels of fasting glucose and lower levels of HDL-cholesterol. Men had higher values of WC when compared to women, but according to WC acceptable cutoff values (<88 cm) the women showed higher risk for cardiovascular disease when compared to men (<102 cm).

Regarding to anthropometric indexes and metabolic profile, BMI was significantly correlated with SBP (r=0.28, p<0.001) and HDL-cholesterol (-0.27, p<0.05); WC was correlated only with HDL-cholesterol (r=-0.35, p<0.001) and LAP (log-transformed) was significantly correlated with total cholesterol (r=0.22, p<0.05), HDL-cholesterol (r=-0.44, p<0.001), fasting glucose (log-transformed: r=0.20, p<0.05) and SBP (r=0.26, p<0.05). None of the anthropometric indexes were significantly correlated with LDL-cholesterol and DBP.

After adjustment for confounding factors (Table II), BMI remained associated with HDL-cholesterol (p=0.02) and SBP (p=0.02), WC showed an inverse association with HDL-cholesterol (p=0.009) and LAP was significantly associated with HDL-cholesterol (p<0.001), fasting glucose (p=0.02) and SBP (p=0.03); however, there was no association between LAP and total cholesterol after adjustment for age, sex and physical activity (p=0.07, trend toward).

Table I
Characteristics of the sample (n=90)

	Mean ± SD, [n(%)]
Age (years)	55.03 ± 14.86
Gender	
Male	43 (47.8)
Female	47 (52.2)
Scholarity (years)	7.02 ± 3.89
IPAQ (level of physical activity)	
Very actives/actives	26 (28.9)
Irregulary actives	27 (30.0)
Sedentary	37 (41.1)
Waist circumference, in cm	
Male	97.52 ± 11.89
Female	95.46 ± 15.57
Body Mass Index (BMI, Kg/m^2)	26.88 ± 4.91
Lipid Accumulation Product Index (LAP, cm.mmol.l)*	3.91 ± 0.75
Total cholesterol (mg/dL)	191.62 ± 50.33
HDL-cholesterol (mg/dL)	
Male	42.50 ± 18.23
Female	48.17 ± 19.40
LDL-cholesterol (mg/dL)	117.26 ± 43.79
Fasting glucose (mg/dL)	137.68 ± 109.79
Systolic blood pressure (SBP, mmHg)	122.87 ± 12.92
Diastolic blood pressure (DBP, mmHg)	77.09 ± 7.97

IPAQ - International Physical Activity Questionnaire;
*variables log-transformed.

Discussion

To our knowledge, this is the first study that evaluated a possible relationship between LAP Index and metabolic profile in hospitalized patients, showing that LAP had a greater discriminatory power to detect a worse metabolic status when compared to other traditional anthropometric measurements as BMI and WC, after controlling for physical activity and other factors. Our study showed also a high prevalence of overall obesity and sedentarism, reflecting the nutritional status and the lifestyle behavior observed in the general population.

Similar to our findings, other authors also detected correlations with LAP Index and fasting glucose, HDL-cholesterol and SBP in both general population and in patients at higher cardiovascular risk[4,8,11]. Likewise, they did not find significant results regarding DBP[4], LDL- cholesterol and LAP Index after controlling for other variables, and also showed significant associations with BMI and BP[9] and regarding waist circumference and HDL-cholesterol[1]. In many population overall adiposity remains strongly associated with both BP and lipid profile; body composition differs substantially according to several ethnics, and most of the studies that evaluated LAP Index were made among Americans, European and Eastern people. However, our results from a highly mixed Brazilian population remain similar, showing that the LAP Index seems really to discriminate biochemical markers and BP independently of general adiposity.

Insulin resistance (IR) is often observed in individuals with visceral obesity, independently of the glycemia levels. Furthermore, IR is involved in a variety of conditions such as dyslipidemia, hypertension and T2DM. In our sample, we did not evaluate indicators of IR; however, inpatients had higher values of WC in concomitance with elevated blood glucose levels. Thus, some individuals may have a silent Ir, and the LAP Index have been strongly associated with this condition in patients with and without T2DM[8,11-13].

Table II
Multivariate analysis for the association of waist circumference and LAP Index with metabolic profile*

Variable	β	*SE*	*CI 95%*	*P-value*
Body Mass Index (kg/m²)				
HDL-cholesterol (mg/dL)	-0.9	0.4	-1.7 – -0.1	0.02
Systolic blood pressure (mmHg)	0.7	0.3	0.1 – 1.2	0.02
Waist circumference (cm)				
HDL-cholesterol (mg/dL)	-0.4	0.2	-0.8 – -0.1	0.009
LAP Index (cm.mmol.l)**				
Total cholesterol (mg/dL)	14.1	7.7	-1.2 – 29.4	0.07
HDL-cholesterol (mg/dL)	-10.8	2.5	-15.8 – -5.8	<0.001
Fasting glucose (mg/dL)**	0.22	0.1	0.0 – 0.4	0.02
Sistolic blood pressure (mm Hg)	4.1	1.9	0.4 – 7.9	0.03

*Multiple Linear Regression adjusted for gender, age and physical activity.
LAP: Lipid Accumulation Product; ** variable log-transformed

Some limitations of this exploratory study are the sample size, the lack of an imaging method to confirm a truthful correlation between LAP Index and visceral adipose tissue and its cross-sectional design, which differently from a longitudinal study does not detect the real risk between LAP Index and the worsening of metabolic status. Besides, no data was available about cholesterol, BP and glucose lowering drugs. However, we emphasize that our data are very informative since LAP Index is an easy and practical tool to detect interactions between excess of adiposity and metabolic data with more precision when compared to WC alone, and it could be used including in patients whose weight and height could not be evaluated.

In conclusion, we found a positive relation of LAP Index and metabolic profile in hospitalized patients, independently of age, sex and levels of physical activity. Our data need to be confirmed in other populations, but this simple tool for assessment of visceral adiposity should be considered in the clinical practice.

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