ISSN (electrónico): 1699-5198 - ISSN (papel): 0212-1611 - CODEN NUHOEQ S.V.R. 318

ARÁN

Nutrición Hospitalaria

Trabajo Original

Obesidad y síndrome metabólico

Relationship between serum omentin-1 levels and nascent metabolic syndrome in Caucasian patients with obesity

Relación entre los niveles séricos de omentina-1 y el síndrome metabólico incipiente en pacientes caucásicos con obesidad

Daniel A. de Luis, Olatz Izaola, David Primo

Centro de Investigación en Endocrinología y Nutrición Clínica (IENVA). Facultad de Medicina. Servicio de Endocrinología y Nutrición. Hospital Clínico Universitario. Universidad de Valladolid. Valladolid, Spain

Abstract

Background and aims: omentin-1 might present a potential role in metabolic syndrome (MS). The aim of our investigation was to evaluate the relationship between omentin-1 and nascent MS.

Methods: we carried out a cross-sectional study in 606 obese subjects. Adiposity parameters, blood pressure, fasting blood glucose, insulin levels, insulin resistance (HOMA-IR), triglyceride and glucose index (TyG), lipid profile, C-reactive protein, omentin-1, and prevalence of nascent MS were determined.

Results: 307 subjects had MS (49.2 %) and 299 did not show MS (50.8 %). Subjects without MS have higher omentin-1 levels (delta: 78.0 ± 13.8 ng/ml; $p = 0.01$). A negative correlation was observed between omentin-1 and adiposity parameters, glucose, insulin, HOMA-IR, TyG index and triglycerides in both groups. And a positive correlation was observed with HDL-cholesterol. BMI (OR = 1.17, 95 % CI = 1.09-1.31; $p = 0.02$), HOMA-IR (OR = 5.21, 95 % CI = 1.69-21.11; $p = 0.01$) and omentin-1 (OR = 0.95, 95 % CI = 0.94-0.97; $p = 0.02$) remained in the final model as predictors of MS. The cut-off point according to the Youden index was 372.45 ng/ml of omentin-1, to predict MS.

Conclusions: Caucasian patients with obesity had clearly lower serum omentin-1 levels in the presence of nascent MS. An inverse correlation was demonstrated with adiposity parameters, insulin resistance and triglycerides. And a direct correlation with HDL-cholesterol was reported.

Keywords:

Insulin resistance. Nascent metabolic syndrome. Obesity. Omentin-1.

Received: 21/04/2024 • Accepted: 23/10/2024

Funding: no funding was received for this study.

Authors´ contributions: D.A. de Luis designed the study an wrote the article. O. Izaola performed the nutritional evaluation. D. Primo performed the biochemical analysis.

Data availability statement: all data generated or analysed during this study are included in this article. Further enquiries can be directed to the corresponding author.

Ethical statement: all patients provided written and informed consent, and the protocol complied with the Declaration of Helsinki as well as with local institutional guidelines. It was approved by the Ethics Committee (code of registration 06/2021).

Conflicts of interest: there are no conflicts of interest related to the study design or its results.

Artificial intelligence: the authors declare not to have used artificial intelligence (AI) or any AI-assisted technologies in the elaboration of the article.

De Luis DA, Izaola O, Primo D. Relationship between serum omentin-1 levels and nascent metabolic syndrome in Caucasian patients with obesity. Nutr Hosp 2024;41(6):1231-1237
DOI: http://dx.doi.org/10.20960/nh.05275

Correspondence:
Daniel A. de Luis. Centro de Investigación en Endocrinología y Nutrición Clínica. Facultad de Medicina. Universidad de Valladolid. C/ Los Perales 16, 47130 Simancas, Valladolid. Spain.
e-mail: dadluis@yahoo.es

Resumen

Antecedentes y objetivos: la omentina-1 podría tener un papel potencial en el síndrome metabólico (SM). El objetivo de nuestra investigación fue evaluar la relación entre la omentina-1 y el SM incipiente.

Métodos: realizamos un estudio transversal en 606 sujetos obesos. Se determinaron los parámetros de adiposidad, la presión arterial, la glucemia en ayunas, los niveles de insulina, la resistencia a la insulina (HOMA-IR), el *índice de triglicéridos y glucosa (*TyG), el perfil lipídico, la proteína C-reactiva, la omentina-1 y la prevalencia del SM incipiente.

Resultados: 307 sujetos tenían SM (49,2 %) y 299 no presentaban SM (50,8 %). Los sujetos sin SM tienen niveles más altos de omentina-1 (delta: 78,0 ± 13,8 ng/ml; $p = 0,01$). Se observó una correlación negativa entre la omentina-1 y los parámetros de adiposidad, la glucosa, la insulina, el HOMA-IR, el *índice* TyG y los triglicéridos en ambos grupos. Se observó una correlación positiva con el colesterol HDL. EL IMC (OR = 1,17, IC 95 % = 1,09-1,31; $p = 0,02$), el HOMA-IR (OR = 5,21, IC 95 % = 1,69-21,11; $p = 0,01$) y la omentina-1 (OR = 0,95, IC 95 % = 0,94-0,97; $p = 0,02$) permanecieron en el modelo final como predictores del SM. El punto de corte según el índice de Youden fue 372,45 ng/ml de omentina-1 para predecir el SM.

Conclusiones: los pacientes caucásicos con obesidad tenían niveles séricos de omentina-1 claramente más bajos en presencia de SM incipiente. Se demostró una correlación inversa con los parámetros de adiposidad, resistencia a la insulina y triglicéridos. Y se detectó una correlación directa con el colesterol HDL.

Palabras clave:

Resistencia a la insulina. Síndrome metabólico naciente. Obesidad. Omentina-1.

INTRODUCTION

Obesity is an important health problem with huge dimensions (1), leading to a metabolic dysfunction. The adipose tissue is a storage organ, but the role of adipose tissue as an endocrine organ has emerged (2). Adipokines are secreted by different cells of this tissue such as adipocytes, macrophages, mast cell and stromal vascular. These adipokines could be related with the pathogenesis of insulin resistance, hypertension, dyslipemia and other cardiovascular risk factors related with obesity (3) and in this context, omentin-1 is one of them.

Omentin-1 is a 32 kDa protein that is secreted by stromal vascular cells in visceral adipose tissue, and it is expressed in other tissues such as lung, heart and placenta (4). This adipokine is a beneficial molecule that improve insulin-stimulated glucose uptake and triggers Akt pathway, which produces downstream effects such as glucose metabolism (5). Circulating omentin-1 correlated negatively with anthropometric parameters such as weight, body mass index (BMI), waist circumference and biochemical parameters (fasting insulin, HOMA-IR and leptin) and positively with high density lipoprotein cholesterol (HDL-C) and adiponectin levels (6).

Metabolic syndrome (MS) is a constellation of risk entities related with obesity, including glucose intolerance or diabetes *mellitus,* abdominal obesity, hyperlipidemia and high blood pressure levels (7). MS is considered a polygenic and multifactorial disorder due to interaction of numerous genes with environmental factors and in this context, adipose tissue develops an important role in the presence of this entity (8). Adipose tissue dysregulation and altered secretion of different adipokines are presented in this syndrome (9,10). Moreover, few studies have evaluated the relationship between MS and circulating levels of omentin-1 in obese patients without cardiovascular events (11-13), this type of MS without cardiovascular events or diabetes *mellitus* is called nascent MS. For example, Jialal et al. (12) reported lower levels of omentin-1 in patients with MS than in patients without MS. This study was realized in a small sample of 75 subjects, of which 30 had nascent MS. In other small sample of 93 adults, Vu et al. (13) reported an association between this adipokine and MS only in males. These preliminary findings have not been evaluated in large samples of patients that represent the wide range of patients with obesity.

The aim of our investigation was to evaluate the potential relationship between circulating omentin-1 levels with nascent MS and its components in an important sample of Caucasian patients with obesity.

MATERIALS AND METHODS

SUBJECTS AND PROCEDURE

This cross-sectional study was performed in a population of 606 Caucasian patients with obesity (20 to 70 years) of age remitted to our Nutritional Unit in a Health Area of the Castilla y León Autonomous Community in Spain. Consecutive volunteers with body mass index (BMI) ≥ 30 kg/m^2 were included. The inclusion criteria for the study protocol were the following — body mass index ≥ 30 kg/m^2 and an age in the range 20-70 years. Exclusion criteria were any of the next conditions: diabetes *mellitus,* cardiovascular events, chronic kidney disease, chronic liver disease, heart failure, malignant tumours and history of alcoholism, or use of medications that potentially influenced weight or metabolic parameters (statins, fibrates and drugs against diabetes *mellitus* or hypertension). Finally, all patients provided their written and informed consent, and the protocol complied with the Declaration of Helsinki as well as with local institutional guidelines. It was approved by the hospital's Ethics Committee (code of registration 06/2021).

Demographic and clinical characteristics of all patients were recorded in the hospital registry system. The parameters of the present study included sociodemographic data, classical anthropometric parameters (weight, height, body mass index (BMI) and waist circumference), total fat mass (FM) by bioimpedance, blood pressure, and biochemical assessment. During the baseline visit 15 ml of venous blood after an 8 hour overnight fast were aliquoted in ethyllenediaminetetraacetic acid (EDTA)-coated tubes for biochemical analysis. The Adult Treatment Panel III

(ATPIII) criteria: elevated fasting glucose or treatment for diabetes *mellitus,* elevated triglycerides (> 150 mg/dl), low HDL cholesterol < 40 mg/dl (males) or < 50 mg/dl (females), elevated systolic or diastolic blood pressure (> 130/85 mmHg) and increased waist circumference (> 88 cm in females and > 102 cm in males) were used to diagnosis nascent MS. Patients meeting at least 3 of these above-mentioned criteria were included in the MS+ group and those not meeting these criteria in the MS- group.

ANTHROPOMETRIC PARAMETERS AND BLOOD PRESSURE

Height and weight measurements were performed while patients were wearing light clothes and no shoes. Body height (cm) was determined using a standard height measurement scale (Omrom, LA, CA, USA) and body weight was measured using digital scales (Omrom, LA, CA, USA). Body mass index (BMI) was calculated using the formula (weight (kg) / height^2 (m)). Waist circumference was measured at the nearest 0.1 cm just above the ilium with a flexible standard tape (Omrom, LA, CA). Body fat mass was determined by impedance with an accuracy of 50 g (14) (EFG BIA 101 Anniversary, Akern, It).

Finally, systolic and diastolic blood pressures were measured two consecutive times on the right arm after 10 minutes rest at the heart level with and automated monitor (Omrom, LA, CA, USA), and the average of both measures was calculated.

BIOCHEMICAL PROCEDURES

Serum biochemistry analyses for glucose, insulin, C-reactive protein (CRP), total cholesterol, HDL-cholesterol, triglyceride, and interleukine-6 were realized using the COBAS INTEGRA 400 analyser (Roche Diagnostic, Basel, Switzerland). LDL cholesterol was calculated using Friedewald's equation (LDL cholesterol = total cholesterol - HDL cholesterol – triglycerides / 5) (15). Based on these parameters, the homeostasis model assessment for insulin resistance (HOMA-IR) was obtained using these values (glucose (mml/L) x insulin (IU/L) / 22.5) (16). The triglyceride glucose index (TyG) was calculated using the formula: ln(fasting TG (mg/dl) x fasting blood glucose (mg/dl) / 2) (17).

STATISTICAL ANALYSIS

All statistical data were analyzed using the SPSS ver.23 (IBM) software (SPSS Inc. Chicago, IL). Sample size (n = 600) was calculated to find a difference in omentin-1 levels greater than 50 ng/ml between the two groups of patients (MS- vs. MS+). The normality of the variables was tested using the Kolmogorov-Smirnov test. Mean ± standard deviation was used to express continuous variables. Categorical variables were presented as percentages. Continuous variables were compared with Student's t-test (for normally distributed variables) or the Mann-Whitney U-test (for non-normally-distributed variables). Differences between categorical variables were determined using the Chi-squared test. The relationship between omentin-1 levels and other variables was evaluated using Pearson´s correlation analysis. A multivariate logistic regression analysis was performed using a backward stepwise method to identify independent variables for MS. The Receptor Operation Characteristic Curve for MS was used to determine the best cutoff point of omentin-1 in predicting MS. And the cutoff points were elucidated by two methods: the area under the curve (AUC) that had the best specificity and sensitivity values for the test in question, and the Youden index as (sensitivity + specificity) - 1). p-values below 0.05 were considered statistically significant.

RESULTS

A total of 606 Caucasian patients with obesity were evaluated, 150 males (24.8 %) and 456 females (75.3 %) with an average age of 49.3 ± 13.3 years (range: 31-68). A total of 307 subjects had MS (49.2 %) and 299 did not show MS (50.8 %). Mean age in the metabolic syndrome (MS+) group was higher (50.6 ± 3.9 years vs 45.9 ± 6.2 years: p = 0.02) than in the non-metabolic syndrome group (MS-). The proportions of females were higher in both groups (MS+ group, 24.7 % males vs 75.3 % females; p = 0.01, and MS- group, 24.6 % males vs 75.4 % females; p = 0.02). No differences in the percentages of both groups were detected.

The basic demographic and clinical characteristics of the population are showed in table I. We reported statistical differences (delta; p-values) between both groups in BMI (3.1 ± 0.2 kg/m^2; p = 0.02), body weight (8.8 ± 2.1 kg; p = 0.03), body fat mass (5.0 ± 0.2 kg; p = 0.03) and waist circumference (11.6 ± 2.5 cm; p = 0.02). All these parameters were higher in MS+ group than MS- group. Systolic blood pressure (6.3 ± 2.6 mmHg; p = 0.01) and diastolic blood pressure (6.5 ± 2.1 mmHg; p = 0.02) were higher in the MS+ group than in the MS- group, too.

Laboratory findings according to MS group are summarized in table II. We observed higher levels in the MS+ group than in the MS- group in the following parameters (delta; p-values): fasting glucose (16.0 ± 2.9 mg/dL; p = 0.01), HDL-cholesterol (-3.5 ± 0.3 mg/dl; p = 0.03), triglycerides (31.1 ± 4.5 mg/dl; p = 0.01), insulin levels (4.1 ± 0.4 UI/L; p = 0.02), HOMA-IR (1.8 ± 0.3 units; p = 0.03), omentin-1 levels (78.0 ± 13.8 ng/ml; p = 0.01) and TyG index (0.50 ± 0.01 mg/dl; p = 0.02). Total cholesterol, LDL-cholesterol, and CRP levels were similar in both groups.

Table III shows the percentage of each metabolic syndrome criterion in the MS+ group vs the MS- group. As expected, the percentages of central obesity, hypertriglyceridemia, low-HDL cholesterol, hypertension and hyperglycemia were higher in the MS+ group than in the MS- group. Omentin-1 levels according to the number of MS criteria decreased as the number of criteria were aggregated (0 criteria, 715.4 ± 13.2 ng/ml; 1 criterion, 533.5 ± 12.2 ng/ml; 2 criteria, 520.6 ± 11.1 ng/ml; 3 criteria,

511.8 ± 9.1 units; 4 criteria, 488.1 ± 8.2 units, and 5 criteria, 452.1 ± 8.1 ng/ml; $p = 0.001$).

Table IV describes correlations between different parameters and omentin-1 levels. A negative correlation was observed between omentin-1 and adiposity parameters, glucose, insulin, HOMA-IR, TyG index and triglycerides in both groups. And a positive correlation was observed between omentin-1 and HDL-cholesterol, too.

The multivariate logistic regression analysis was performed including variables with $p < 0.25$ between groups in the univariate analysis but not showing collinearity and excluding variables used as criteria of MS. BMI (OR = 1.17, 95 % CI = 1.09-1.31; $p = 0.02$), HOMA-IR (OR = 5.21, 95 % CI = 1.69-21.11; $p = 0.01$) and omentin-1 (OR = 0.95, 95 % CI = 0.94-0.97; $p = 0.02$) remained in the final model as independent predictors of MS.

The ROC curve of the omentin-1 for MS is shown in figure 1. The area under the curve (AUC) according to ATPIII criteria showed a value of 0.721 (0.694-0.792: $p = 0.001$). The cut-off point according to the Youden index was 372.45 ng/ml of omentin-1 to predict MS, with a sentivity and specificity of 80.9 % and 70.2 %, respectively.

Table I. Basic demographic and clinical characteristics of the Caucasian patients with obesity

Parameters	All population *n* = 606	MS- group *n* = 307	MS+ group *n* = 299	*p*
Age	49.3 ± 13.3	49.0 ± 12.1	49.8 ± 7.3	0.62
BMI	36.3 ± 1.4	34.2 ± 0.9	37.9 ± 0.4	0.02
Weight (kg)	94.7 ± 6.1	90.1 ± 7.1	98.9 ± 5.9	0.03
Fat mass (kg)	38.6 ± 9.1	36.3 ± 2.1	41.3 ± 1.2	0.03
WC (cm)	110.1 ± 4.1	105.2 ± 3.1	116.8 ± 2.9	0.02
SBP (mmHg)	126.8 ± 2.3	120.5 ± 3.1	128.9 ± 2.8	0.01
DBP (mmHg)	81.9 ± 3.1	75.5 ± 4.1	83.8 ± 3.2	0.02

BMI: body mass index; DBP: diastolic blood pressure; SBP: systolic blood pressure; WC: waist circumference. Statistical differences between groups ($p < 0.05$).

Table II. Laboratory findings of Caucasian patients with obesity (mean ± SD)

Parameters	All population *n* = 606	MS- group *n* = 307	MS+ group *n* = 299	*p*
Fasting glucose (mg/dl)	100.2 ± 4.1	93.0 ± 2.9	109.3 ± 2.1	0.01
Total cholesterol (mg/dl)	203.4 ± 11.8	200.8 ± 11.2	210.8 ± 12.2	0.29
LDL-cholesterol (mg/dl)	124.6 ± 12.9	122.4 ± 7.9	132.8 ± 5.9	0.18
HDL-cholesterol (mg/dl)	52.1 ± 2.1	55.4 ± 1.4	52.0 ± 1.2	0.03
Triglycerides (mg/dl)	125.1 ± 8.0	110.4 ± 9.5	141.1 ± 10.3	0.01
Insulin (mUI/l)	13.9 ± 1.1	12.4 ± 0.9	16.4 ± 0.7	0.02
HOMA-IR	3.4 ± 0.3	2.9 ± 0.5	4.7 ± 0.3	0.02
CRP (mg/dl)	5.9 ± 0.7	5.8 ± 0.8	6.1 ± 1.9	0.12
Omentin-1 (ng/ml)	510.1 ± 13.4	521.2 ± 15.8	443.8 ± 12.9	0.02
TyG	4.61 ± 0.3	4.50 ± 0.2	4.99 ± 0.1	0.02

HOMA-IR: homeostasis model assessment of insulin resistance; CRP: C-reactive protein; TyG: triglyceride glucose index. Statistical differences between groups ($p < 0.05$).

Table III. Metabolic syndrome and components of metabolic syndrome in Caucasian patients with obesity

Parameters	All population *n* = 606	MS- group *n* = 307	MS+ group *n* = 299	*p*
Percentage of MS	49.2 %	0 %	100 %	0.01
Percentage of central obesity	73.4 %	53.9 %	93.3 %	0.01
Percentage of hypertrigliceridemia	9.4 %	3.9 %	12.3 %	0.02
Low HDL-cholesterol	28.0 %	12.7 %	43.4 %	0.03
Percentage of hypertension	45.7 %	14.9 %	76.9 %	0.02
Percentage of hyperglycaemia	23.4 %	7.1 %	40.2 %	0.01

The following cutoff points were used for the criteria of: central obesity (waist circumference > 88 cm in females and > 102 in males), hypertension (systolic BP > 130 mmHg or diastolic BP > 85 mmHg or specific treatment), hypertriglyceridemia (triglycerides > 150 mg/dl or specific treatment) or hyperglycaemia (fasting plasma glucose > 110 mg/dl). Statistical differences between groups ($p < 0.05$).

Table IV. Correlation analysis of omentin with other parameters

Parameters	All population *n* = 606	MS- group *n* = 307	MS+ group *n* = 299
Age (years)	$r = 0.17$, $p = 0.23$	$r = 0.23$, $p = 0.22$	$r = 0.18$, $p = 0.31$
glucose (mg/dL)	$r = 0.11$, $p = 0.41$	$r = 0.12$, $p = 0.43$	$r = 0.10$, $p = 0.33$
LDL-cholesterol (mg/dL)	$r = 0.06$, $p = 0.52$	$r = 0.08$, $p = 0.43$	$r = 0.07$, $p = 0.52$
HDL-cholesterol (mg/dl)	$r = 0.30$, $p = 0.01$	$r = 0.28$, $p = 0.01$	$r = 0.33$, $p = 0.01$
Triglycerides (mg/dl)	$r = -0.29$, $p = 0.02$	$r = -0.31$, $p = 0.02$	$r = -0.27$, $p = 0.03$
Insulin (UI/L)	$r = -0.32$, $p = 0.02$	$r = -0.29$, $p = 0.02$	$r = -0.35$, $p = 0.01$
HOMA-IR	$r = -0.36$, $p = 0.02$	$r = -0.27$, $p = 0.03$	$r = 0.40$, $p = 0.01$
TyG index	$r = -0.35$, $p = 0.02$	$r = -0.28$, $p = 0.02$	$r = 0.39$, $p = 0.01$
Weight (kg)	$r = -0.21$, $p = 0.01$	$r = -0.15$, $p = 0.02$	$r = -0.24$, $p = 0.02$
Fat mass (kg)	$r = -0.17$, $p = 0.03$	$r = -0.15$, $p = 0.03$	$r = -0.21$, $p = 0.02$
Waist circumference (cm)	$r = -0.28$, $p = 0.001$	$r = -0.21$, $p = 0.003$	$r = 0.34$, $p = 0.002$

CRP: C-reactive protein; HOMA-IR: homeostasis model assessment. Statistical differences between groups ($p < 0.05$).

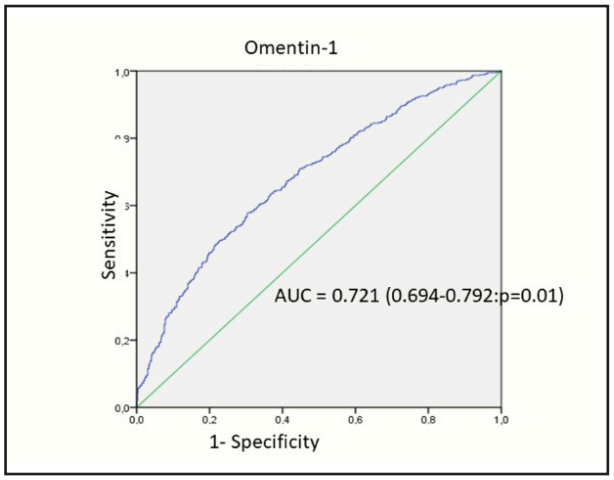

Figure 1.
ROC curve of omentin-1 for metabolic syndrome according to the ATPIII criteria.

DISCUSSION

In our study, patients with obesity and nascent MS had significantly lower levels of omentin-1 compared with patients without MS. In all patients omentin-1 levels showed a significant negative correlation with insulin resistance as estimated by HOMA-IR and TyG index, adiposity parameters and triglyceride levels. A positive correlation with HDL-cholesterol was observed, too.

In small previous studies, Jialal et al. (12) showed that the adipose tissue of patients (n = 45) with nascent MS secreted lower omentin-1 levels than the adipose tissue of patients (n = 30) without MS. To our knowledge, this is the first study to validate these findings in an important sample of Caucasian patients with obesity, and to give a cut-off value of omentin-1 to predict nascent MS. Similar to our study, other study demonstrated lower levels of omentin-1 in patients with nascent MS compared with patients without MS (18). This work was carried out in a different sample than ours, composed of a sample of 110 Turkish patients with MS, all with high blood pressure. In other small sample of 93 adults, Vu et al. (13) reported an association between this adipokine and MS only in males. In comparison with these above-mentioned investigations, decreased circulating omentin-1 in subjects with MS in our study were more pronounced. This relationship has also been found in studies carried out with obese adolescents (19), but in the literature there are also studies that have demonstrated a lack of difference in the levels of omentin-1 depending on the presence or absence of MS (20). These contradictory results depended on age, gender distribution, average BMI, ethnic diversity, study design, exclusion and inclusion criteria, heterogeneity or predominance of MS components, and measurements techniques.

In addition to the difference in omentin-1 levels depending on the presence of MS in our obese patients, we also demonstrated a significant inverse correlation between insulin resistance estimated as TyG index and HOMA-IR. It has been postulated that omentin-1 contributes to insulin sensitivity through the modulation of protein kinase (Akt/protein kinase B). In one study, HOMA-IR was related to decreased circulating omentin-1 levels (21), and these results were replicated with TyG, too (12). Another design showed that weight loss with different hypocaloric diets produced parallel significant decreased values of omentin-1 and insulin resistance (22).

In addition, we reported that levels of omentin-1 were inversely correlated with adiposity parameters (BMI, fat mass and waist circumference). Obesity is a well-known chronic low-grade inflammatory condition and may change circulating adipokine levels secondary to adipocyte dysregulation in visceral adipose tissue. This increase of visceral adipose tissue has been related with a decrease in omentin-1 gene expression (23). However, there are discrepancies between studies investigating this relationship and some of them failed to detect this correlation (24). These inconsistencies raise the question of whether omentin-1 levels are regulated by the obesity status or by the inflammation process triggered by obesity.

The positive correlation between HDL cholesterol and omentin-1 has been previously reported in different studies (25). A potential explanation for this association is that dysregulation of omentin-1 may adversely affect insulin signaling and regulation, thereby modifying HDL production (26). Some studies have explained the potential protective role of omentin-1 concentrations against coronary artery disease through this association with HDL-cholesterol (27).

There were some limitations to our study. First, the study has been designed in Caucasian adults with obesity, so the data are not generalizable to younger subjects, overweight patients, or other ethnicities. Secondly, the design as a cross-sectional design (transversal) does not allow to extract causality. Third, we did not directly measure the visceral distribution of fat, only indirect parameters such as waist circumference were used. Fourth, patients with diabetes *mellitus* were not included. However, patients with impaired glucose tolerance may have been enrolled in this design as oral a glucose tolerance test was not carried out as routine screening test, and this fact may affect the findings. Finally, physical activity has not been evaluated, and it has a potential role in omentin-1 levels (28). The strengths of our study were that we studied a representative population of obese patients with a median age of predominantly females.

The results from our design showed that Caucasian patients with obesity had clearly lower serum omentin-1 levels in the presence of nascent MS. An inverse correlation was demonstrated with adiposity parameters, insulin resistance and triglycerides, with direct correlation with HDL-cholesterol. All this allows to consider that omentin-1 may play a partial role in the development of MS and may be a predictive marker of MS and metabolic health status, too (29).

REFERENCES

1. Ng M, Fleming T, Robinson M, Thomson B, Graetz N, Margono C, et al. Global, regional, and national prevalence of overweight and obesity in children and adults during 1980–2013: a systematic analysis for the global burden of disease study 2013. Lancet 2014;384:766-81. DOI: 10.1016/S0140-6736(14)60460-8
2. Hamdy O . The role of adipose tissue as an endocrine gland. Curr Diab Rep 2005;5:317-9. DOI: 10.1007/s11892-005-0086-0
3. Maury E, Brichard SM. Adipokine dysregulation, adipose tissue inflammation and metabolic syndrome. Mol Cell Endocrinol 2010;314:1-16. DOI: 10.1016/j.mce.2009.07.031
4. Yang RZ, Lee MJ, Hu H, Pray J, Wu HB, Hansen BC, et al. Identification of omentin as a novel depotspecific adipokine in human adipose tissue: possible role in modulating insulin action. Am J Physiol Endocrinol Metab 2006;290:1253-61. DOI: 10.1152/ajpendo.00572.2004
5. Tan BK, Adya R, Randeva HS. Omentin: a novel link between inflammation, diabesity, and cardiovascular disease. Trends Cardiovasc Med 2010;20:143-8. DOI: 10.1016/j.tcm.2010.12.002
6. Ouchi N, Parker JL, Lugus JJ, Walsh K. Adipokines in inflammation and metabolic disease. Nat Rev Immunol 2011;11:85-97. DOI: 10.1038/nri2921
7. Expert panel on detection, evaluation and treatment of high blood cholesterol in adults (Adult Treatment Panel III). Executive summary of the Third Report of the National Cholesterol Education Program (NCEP). JAMA 2001;285:2486-97. DOI: 10.1001/jama.285.19.2486
8. de Luis DA, Izaola O, Primo D, Aller R. Relation of a variant in adiponectin gene (rs266729) with metabolic syndrome and diabetes mellitus type 2 in

adult obese subjects. Eur Rev Med Pharmacol Sci 2020;24:10646-52. DOI: 10.26355/eurrev_202010_23422
9. Cornier MA, Dabelea D, Hernandez TL, Lindstrom RC, Steig AJ, Stob NR, et al. The metabolic syndrome. Endocr Rev 2008;29:777-822. DOI: 10.1210/er.2008-0024
10. Bremer AA, Devaraj S, Afify A, Jialal I. Adipose tissue dysregulation in patients with metabolic syndrome. J Clin Endocrinol Metab 2011;96:1782-8. DOI: 10.1210/jc.2011-1577
11. Bremer AA, Jialal I. Adipose tissue dysfunction in nascent metabolic syndrome. J Obes 2013;2013:393192. DOI: 10.1155/2013/393192
12. Jialal I, Devaraj S, Adams-Huet B, Chen X, Kaur H. Increased cellular and circulating biomarkers of oxidative stress in nascent metabolic syndrome. J Clin Endocrinol Metab 2012;97:1844-50. DOI: 10.1210/jc.2012-2498
13. Vu A, Sidhom MS, Bredbeck BC, Kosmiski LA, Aquilante CL. Evaluation of the relationship between circulating omentin-1 concentrations and components of the metabolic syndrome in adults without type 2 diabetes or cardiovascular disease. Diabetol Metab Syndr 2014;6:4-10. DOI: 10.1186/1758-5996-6-4
14. Lukaski H, Johnson PE. Assessment of fat-free mass using bioelectrical impedance measurements of the human body. Am J Clin Nutr 1985;41:810-7. DOI: 10.1093/ajcn/41.4.810
15. Friedewald WT, Levy RJ, Fredrickson DS. Estimation of the concentration of low-density lipoprotein cholesterol in plasma without use of the preparative ultracentrifuge. Clin Chem 1972;18:499-502.
16. Mathews DR, Hosker JP, Rudenski AS, Naylor BA, Treacher DF. Homeostasis model assessment: insulin resistance and beta cell function from fasting plasma glucose and insulin concentrations in man. Diabetologia 1985;28:412-4. DOI: 10.1007/BF00280883
17. Primo D, Izaola O, de Luis DA. Triglyceride-Glucose Index Cutoff Point Is an Accurate Marker for Predicting the Prevalence of Metabolic Syndrome in Obese Caucasian Subjects. Ann Nutr Metab 2023;79(2):70-7. DOI: 10.1159/000526988
18. Cetin Sanlialp S, Nar G, Nar R. Relationship between circulating serum omentin-1 levels and nascent metabolic syndrome in patients with hypertension. J Investig Med 2022;70:780-5. DOI: 10.1136/jim-2021-002071
19. Buyukinan M, Atar M, Can U, Pirgon O, Guzelant A, Deniz I. The association between serum vaspin and Omentin-1 levels in obese children with metabolic syndrome. Metab Syndr Relat Disord 2018;16:76-81. DOI: 10.1089/met.2017.0133
20. Kilic DC, Oguz A, Uzunlulu M. Plasma omentin-1 levels are similar in nondiabetic metabolic syndrome patients and healthy subjects. J Endocrinol Metab 2011;1:182-7. DOI: 10.4021/jem46w
21. Zhang Q, Zhu L, Zheng M, Fan C, Li Y, Zhang D, et al. Changes of serum omentin-1 levels in normal subjects, type 2 diabetes and type 2 diabetes with overweight and obesity in Chinese adults. Ann Endocrinol 2014;75:171-5. DOI: 10.1016/j.ando.2014.04.013
22. de Luis D, Izaola O, Primo D, Aller R. A Randomized Trial with Two Hypocaloric Diets with Different Lipid Profiles and Effects on Serum Omentin-1 Levels in Obese Subjects. Dis Markers 2022;2022:6777283. DOI: 10.1155/2022/6777283
23. Hossein-Nezhad A, Mirzaei K, Alatab S. Circulating Omentin-1 in obesity and metabolic syndrome status compared to control subjects. Endocrinol Metabol Syndrome 2012;S1:008. DOI: 10.4172/2161-1017.S1-008
24. de Souza Batista CM, Yang R-Z, Lee M-J, Glynn NM, Yu DZ, Pray J, et al. Omentin plasma levels and gene expression are decreased in obesity. Diabetes 2007;56:1655-61. DOI: 10.2337/db06-1506
25. Greulich S, Chen WJ, Maxhera B, Rijzewijk LJ, van der Meer RW, Jonker JT, et al. Cardioprotective properties of omentin-1 in type 2 diabetes: evidence from clinical and in vitro studies. PLoS One 2013;8:e59697. DOI: 10.1371/journal.pone.0059697
26. Yan P, Liu D, Long M, Ren Y, Pang J, Li R. Changes of serum omentin levels and relationship between omentin and adiponectin concentrations in type 2 diabetes mellitus. Exp Clin Endocrinol Diabetes 2011;119:257-63. DOI: 10.1055/s-0030-1269912
27. Shang FJ, Wang JP, Liu XT, Zheng QS, Xue YS, Wang B, et al. Serum omentin-1 levels are inversely associated with the presence and severity of coronary artery disease in patients with metabolic syndrome. Biomarkers 2011;16:657-62. DOI: 10.3109/1354750X.2011.622789
28. Li S, Xue J, Hong P. Relationships between serum omentin-1 concentration, body composition and physical activity levels in older women. Medicine (Baltimore) 2021;12(100):e25020. DOI: 10.1097/MD.0000000000025020
29. Alizadeh S, Mirzaei K, Mohammadi C, Keshavarz SA, Maghbooli Z. Circulating omentin-1 might be associated with metabolic health status in different phenotypes of body size. Arch Endocrinol Metab 2017;61:567-74. DOI: 10.1590/2359-3997000000269