Prognostic Role of Leptin-to-Adiponectin Ratio in Cardio-Metabolic Risk Assessment in Childhood and Adolescent Obesity: Pre and Post Nutritional Management

Original Article

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ABSTRACT

Background: Adipose tissue secretes multiple adipokines that exhibit essential roles in metabolic regulation. Of these adipokines are leptin and adiponectin, which regulate body weight and energy expenditure. Since leptin and adiponectin change inversely in relation to BMI, their ratio -the leptin/adiponectin (L/A ratio) - has been suggested as a more sensitive marker of metabolic syndrome than their serum concentrations individually.

Aim of the work: evaluate the prognostic value of serum concentrations of the adipokines (leptin, adiponectin, the L/A ratio) in children and adolescents with simple obesity under a nutritional management program and their role in developing cardio-metabolic complications.

Patients and Methods: This study was conducted on 90 children and adolescents (age: 6-18 years) with simple obesity recruited from the Obesity Clinic, Children's Hospital, Ain Shams University. All patients were subjected to the following initially and after 6 months of nutritional management: anthropometric measurements, analysis of body composition, 24-hour diet recall and laboratory investigations including: lipid profile, serum leptin, serum adiponectin and HOMA-IR.

Results: revealed higher values of serum leptin and L/A ratio in the Cardio-Metabolic risk group before and after dietary management than Non-Cardio-Metabolic risk group. After diet control, significant lower adiponectin levels were found in CM risk group. Before management, ROC curve showed that best cut off point for L/A ratio to differentiate between CM risk and non-CM risk groups was found >7.72 with sensitivity of 63.16%, specificity of 78.57% and AUC 71.7%.

Conclusion: Identifying serum leptin /Adiponectin (L/A) ratio would be beneficial tool for the optimum assessment of obesity and its severity.

Key Words: Children, cardiometabolic risk, metabolic syndrome, obesity, leptin and adiponectin.

Received: 3 July 2024, **Accepted:** 18 August 2024.

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ISSN: 2735-3540, Vol. 75, No. 3, September 2024.

INTRODUCTION

The global childhood obesity pandemic is one of the biggest health concerns of this century. In 2016, estimates suggest that 40 million children under the age of 5 years and more than 330 million children and adolescents aged 5 to 19 were overweight or obese and in 2020, these numbers increased even more[1]. Obesity and overweight are defined using body mass index (BMI) percentiles; children >2 years old with a BMI ≥95th percentile meet the criterion for obesity, and those with a BMI between the 85th and 95th percentiles are in the overweight range[2]. Treating pediatric obesity is complex, and children with overweight are likely to become obese adults. Pediatric obesity also shows many complications in many body systems, including the endocrine, gastrointestinal, pulmonary, cardiovascular, and musculoskeletal systems, that should be treated to decrease the risk for later morbidity and mortality[3,4]. In addition, the metabolic syndrome that comprises central obesity, hypertension, glucose intolerance, and hyperlipidemia can include comorbidities such as nonalcoholic fatty liver disease, polycystic ovary syndrome, obstructive sleep apnea, and mental health disorders[5]. Adipose tissue secretes multiple hormones (adipokines) that exhibit essential roles in metabolic regulation and physiological homeostasis. Of these adipokines, leptin and adiponectin, are two important hormones which regulate body weight and energy expenditure[6]. Obesity- related hyperleptinemia and hypoadiponectinemia are associated with metabolic

DOI: 10.21608/ASMJ.2024.301120.1283

complications as insulin resistance, type 2 diabetes and cardiovascular disease[7]. Since leptin and adiponectin change inversely in relation to BMI, their ratio -the leptin/adiponectin (L/A ratio) - has been suggested as a more sensitive marker of metabolic syndrome than serum concentrations of leptin or adiponectin, individually. L/A ratio has been suggested as a predictor of metabolic conditions[7].

In this context, the current study aimed to evaluate the prognostic value of serum concentrations of the adipokines (leptin, adiponectin, the L/A ratio) in children and adolescents with simple obesity under a nutritional management program and their role in developing cardio-metabolic complications.

PATIENTS AND METHODS

Study Population

This prospective study was conducted on 90 children and adolescents (age: 6-18 years) with simple obesity (BMI more than 95th percentile) recruited before the start of nutritional management from the Obesity Clinic, Children's Hospital, Ain Shams University, Cairo, Egypt, from May 2021 to May 2022. Exclusion criteria were: (a) patients with type 1 diabetes mellitus; (b) those receiving any drug causing obesity such as steroids and phenytoin; and (c) those with congenital or acquired cardiac diseases and syndromic causes of obesity or any cause other than simple obesity.

Medical History and Physical Examination

Full medical history including both personal and family history were taken from each child or adolescent participating in the study either from the patients themselves if appropriate or through the legal guardians or parents. Additionally, clinical assessment, including full anthropometric measurements; weight, height, calculation of body mass index (BMI), and their SDS was calculated, waist circumference, hip circumference and waist/ hip ratio[8], vital data assessment and puberty evaluation by Tanner staging, was done by expert endocrinologist in the Obesity clinic[9]. In addition, analysis of body composition was performed using the Tanita SC-330 body composition analyzer, which gives information about body water, fat-free mass, muscle mass and body fat percentage[10].

Weight was measured using a Tanita digital scale with the patient bare feet and wearing the least possible clothes and the reading was taken to the nearest (0.1) kg[8]. Height was measured by using portable (Seca Germany) stadiometer to the nearest 1 mm with bare feet, with the heels, buttocks and shoulders against the stick and the head positioned in the Frankfurt horizontal plane[8]. BMI was calculated according to the formula weight in kg divided by height in meter square[8]. Waist circumference was measured with a measuring tape at the uppermost lateral border of the hip crest. Hip circumference was measured to the nearest 0.1 cm at the maximum girth around the buttocks. W/H ratio and its SDS were calculated[8]. Blood pressure was measured with an electronic sphygmomanometer validated in children, Omron Corporation, Koyoto, Japan after resting for 5 minutes in supine position, blood pressure was measured three times on the right upper arm and average value was taken. Tanner staging was performed by an expert endocrinologist in the Obesity Clinic to differentiate between prepubertal (Tanner 1) and pubertal (Tanner 2-5) stages.

Cardiometabolic risk factors (CMRFs)

CMRF values were defined as follows: total cholesterol (TC) ≥200 mg/dL, high-density lipoprotein cholesterol (HDL-c) <40 mg/dL, low-density lipoprotein cholesterol (LDL-c) ≥130 mg/ dL, triglycerides (TG) ≥150 mg/dL, non-HDL-c ≥145 mg/dL, systolic blood pressure (BP) ≥95th percentile or diastolic BP ≥95th percentile for sex, age and height according to the American Academy of Pediatrics[7, 11], fasting blood sugar (FBG) ≥100 mg/dL or HbA1c ≥5.7%[12]. Upon this definition, subjects were divided into two groups according to presence of one of these CMRFs or absence of them all; the CMRF group included 76 children (84.4%), and the non-CMRF group included 14 children (15.6%).

Nutritional Assessment

A 24-hour diet recall was assessed in each patient to help tailoring a specific nutritional management program for each of them separately to gain the maximum benefit. Food composition analysis in detailed including micro and macronutrients was done based on food composition tables of National Nutrition Institute (NNI) 2006[13].

Blood Sampling and Laboratory Investigations

Under complete aseptic precautions, five milliliters of venous blood were collected from each participant after an overnight fast into a serum separation vacutainer tube. Separated sera were used for assessing the following parameters at the basal level and after six months of

nutritional management according to pediatric obesity algorithm diagnosis and management[14]: lipid profile and fasting blood glucose (FBG) were assayed by the AU680 Beckman Coulter autoanalyzer (Beckman Coulter, Inc., Brea, CA), fasting serum insulin by a human ELISA kit (Cusabio, Houston, USA; CAT no.: CSB-E05069h) with a sensitivity of 2 µU/ml, serum leptin by a human ELISA kit (BioVendor, Czech Republic, Cat. no: RD191001100) with a sensitivity of 0.2 ng/ml and serum adiponectin by a human ELISA kit (BioVendor, Czech Republic, Cat. no: RD195023100) with a sensitivity of 26 ng/ml. In addition, the Homeostasis Model of Assessment Insulin Resistance (HOMA-IR) was calculated using the following formula: (fasting insulin in µU/ml x fasting glucose in mg/dl)/405[15].

Dietary Management

Each patient received a tailored dietary regimen with age-appropriate portion sizes in the form of three meals and 2 snacks per day for 6 months, moderate to vigorous 60 minutes daily activity was advised to be reached gradually and limiting the screen time less than 2 hours per day was emphasized with close follow up through regular visits to ensure compliance[14].

All physical and laboratory assessment had been done at time of enrollment and 6 months after intervention.

Ethical Considerations

The study protocol was approved by the Research Ethics Committee (REC) of Ain- Shams University, Faculty of Medicine, FWA 000017585 and received a number FMASU MS 286/2020 on 22/4/2020. All children who participated in the study provided written informed consent by their parents or legal guardians. Confidentiality of research data was secured.

Data analysis

The collected data was coded, processed, and analyzed using the SPSS (Statistical Package for Social Sciences) version 23 for Windows® (IBM SPSS Inc, Chicago, IL, USA). Categorical variables were conveyed as frequency with percentage while continuous variables were described as mean and standard deviation (SD) or median with interquartile range (IQR). Quantitative data were tested for normality by Kolmogorov-Smirnov test. The categorical variables were contrasted utilizing Chi-square test or Fisher's exact test. To contrast continuous variables among groups, Student's t test, Mann-Whitney U test and Friedman test were utilized. The statistical significance of the difference between two means assessed twice for the same research group was evaluated using a paired t-test or and Wilcoxon signed-rank test. *P value* <0.05 was considered significant.

RESULTS

Ninety children and adolescents with simple obesity were enrolled, their ages ranged from 6 to 15.3 years old. Demographic data of patients revealed that patients were 54 males (60%) and 36 females (40%). None of the subjects were on regular physical activity. Among the patients; 59 (65.5%) were prepubertal and 31 (34.4%) were pubertal. 81 out of 90 patients (90%) had positive family history of Metabolic Syndrome.

Food analysis of 24 hours by dietary recall before nutritional management showed that 80 patients (88.89%) had high dietary caloric intake beyond the recommended daily allowance for age and sex of total energy, 4 patients (4.44%) had normal caloric intake, while 6 patients (6.66%) had low caloric intake for age. High protein intake in 88 (97.78%) of patients, high CHO intake in 83 (92.23 %) of patients and high fat intake in 42 (46.67%) of patients. Also, low dietary intake of water and fibers was found in all patients (100%). Low dietary intake of potassium in 83 (92.22%), and high dietary sodium intake in 85 (94.44%) of studied patients.

Moreover, there was highly significant decrease in both systolic and diastolic blood pressures after dietary management in all patients with *p-value* 0.008 and < 0.001 respectively.

A highly significant decrease in weight z-score, BMI, BMI z-score was noticed in all subjects with highly significant increase in height after dietary management with *p-value* < 0.001, in all parameters.

Waist circumference, hip circumference and waist/hip ratio showed all a highly significant decrease after dietary management with *p- value* < 0.001.

A significant decrease in body fat percentage was noticed after dietary management, while there was increase in muscle mass and body water percentage as demonstrated in (Table 1).

Table 1: Comparison of patients before and after dietary management regarding body composition analysis and BMI z score.

Items		Before	After	Test value	*P-value*	Sig.
Body Composition and BMI z score						
Body water %	Mean ± SD Range	42.45 ± 6.16 28.11 – 55.9	45.04 ± 7.40 30 – 58.2	-5.310	<0.001**	HS
	Mean ± SD Range	51.74 ± 7.81 29.16 – 70.52	55.63 ± 7.29 36.92 – 70.21	-9.712•	<0.001**	HS
Muscle mass (%)	Low Decreased Good Increased	44 (48.9%) 28 (31.1%) 5 (5.6%) 13 (14.4%)	29 (32.2%) 26 (28.9%) 18 (20.0%) 17 (18.9%)	11.037*	0.012*	S
Body fat (%)	Mean ± SD Range	44.17 ± 7.95 24.57 – 64.27	40.25 ± 7.69 23 – 58.2	10.353	<0.001**	HS
BMI (Z score)	Mean ± SD Range	2.49 ± 0.38 1.65 – 3.24	2.15 ± 0.53 0.89 – 3.02	12.419•	<0.001**	HS
BMI interpretation	Normal <+1 Overweight +1 Obesity +2 Severe Obesity +3	0 11 (12.22%) 75 (83.33%) 4 (4.44%)	1 (1.11%) 30 (33.33%) 58 (64.44%) 1 (1.11%)	13.778*	0.003**	HS

BMI= Body mass index; HS= Highly significant; SD= Standard deviation.

As for lipid profile, a highly significant increase in HDL, while highly significant decrease in LDL, TG, cholesterol, HBA1C, fasting serum insulin and HOMA-IR after dietary management with *p- value* < 0.001.

Additionally, there was significant increase in adiponectin, while leptin and the L/A ratio showed a significant decrease after dietary management with *p-value* of < 0.001 as described in (Table 2) and (Figure 1). Also, the results revealed higher values of serum leptin and L/A ratio in the CM risk group (76 patients) with *p-value* =0.017 and 0.010 respectively before management than Non- CM risk group (14 patients), while serum Adiponectin didn't show statistical difference between the two groups as described in (Table 3). Meanwhile after intervention, higher serum leptin and L/A ratio were found in the CM risk group patients with *p-value* = 0.001 and <0.001 respectively and significant lower adiponectin in comparison to Non- CM risk group patients with *p-value* <0.001 as described in (Table 4) and (Figure 2).

Table 2: Comparison of patients before and after dietary management regarding serum leptin, adiponectin and their ratio.

Items	Mean values	Before	After	Test value	*P-value*	Sig.
Leptin and Adiponectin						
Serum Leptin (ng/ml)	Mean ± SD Range	30.66 ± 7.67 18.24 - 46.5	26.33 ± 8.3 11.58 - 42.59	14.871	<0.001**	HS
Serum Adiponectin (ug/ml)	Mean ± SD Range	3.52 ± 0.65 2.2 - 4.83	4.17 ± 0.84 2.26 - 6.39	12.916	<0.001**	HS
L/A Ratio	Median (IQR) Range	8.23 (6.54 – 11.87) 3.95 – 18.6	5.99 (4.6 – 8.27) 2.59 – 18.85	-7.973≠	<0.001**	HS

L/A ratio= Leptin/Adiponectin ratio; SD=Standard deviation; HS= Highly significant.

Table 3: Comparison of leptin and adiponectin between the CM risk group and the non-CM risk group before nutritional management.

Items before dietary management		Cardiometabolic risk N=76	Non-cardio metabolic risk N=14	Test value	*P-value*	Sig.
Leptin and Adiponectin						
Serum Leptin (ng/ml)	Mean ± SD Range	31.48 ± 7.6 18.24 – 46.5	26.2 ± 6.7 18.34 – 42.38	-2.434•	0.017*	S
Serum Adiponectin (ug/ml)	Mean ± SD Range	3.47 ± 0.65 2.2 – 4.83	3.83 ± 0.57 2.72 – 4.7	1.926•	0.057	NS
L/A Ratio	Median (IQR) Range	8.38 (6.78 – 12.01) 3.95 – 18.6	6.93 (5.14 – 7.72) 4.2 – 12.54	-2.572≠	0.010*	S

Table 4: Comparison of leptin and adiponectin between the CM risk group and the non-CM risk group after nutritional management.

Items after dietary management		Cardio metabolic risk	Non-cardio metabolic risk	Test value	*P-value*	Sig.
		Leptin and Adiponectin				
Serum Leptin (ng/ml)	Mean ± SD Range	27.58 ± 7.91 13.22 – 42.59	19.56 ± 7.23 11.58 – 37.25	-3.530•	0.001**	HS
Serum Adiponectin (ug/ml)	Mean ± SD Range	4.01 ± 0.74 2.26 – 5.37	5.06 ± 0.82 3.49 – 6.39	4.779•	<0.001**	HS
L/A Ratio	Median (IQR) Range	6.44 (5.15 – 9.23) 2.67 – 18.85	3.81 (2.71 – 4.63) 2.59 – 6.99	-4.375≠	<0.001**	HS

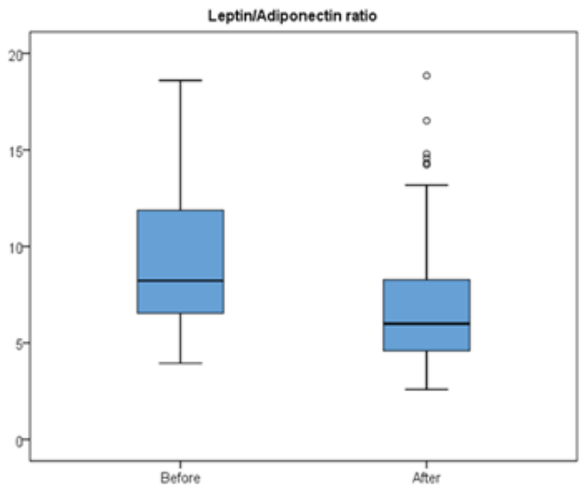

Fig. 1: Leptin / adiponectin ratio before and after dietary management in all studied patients.

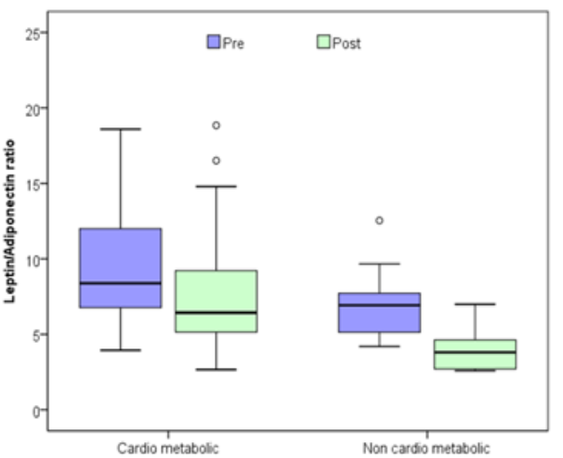

Fig. 2: Leptin/Adiponectin ratio in CM risk group and non-CM risk group patients before and after dietary management.

Before management, ROC curve shows that the best cut off point for serum leptin level to differentiate between CM risk and non-CM risk groups was found >26.27 with sensitivity of 71.05%, specificity of 64.29% and AUC (area under the curve) 71.05%. And L/A ratio to differentiate between CM risk and non-CM risk groups was found >7.72 with sensitivity of 63.16%, specificity of 78.57% and AUC 71.7%, described in (Table 5) and (Figure 3). Meanwhile, after management, ROC curve shows that the best cut off point for serum leptin level to differentiate between CM risk and non-CM risk groups was found >21.39 with sensitivity of 75%, specificity of 78.57% and AUC 80%. And the best cut off point for Adiponectin to differentiate was found ≤4.5 with sensitivity of 73.68%, specificity of 85.71% and AUC 83.4%. And the best cut off point for L/A ratio to differentiate was found >4.64 with sensitivity of 81.58%, specificity of 85.71% and AUC 86.8% as described in (Table 6) and (Figure 4).

Table 5: Cut off values for serum leptin level and L/A ratio to differentiate between the CM risk group and the non-CM risk group before dietary management.

Variable before management	Cut off point	AUC	Sensitivity	Specificity	+PV	-PV
Serum Leptin	>26.27	0.705	71.05	64.29	91.5	29.0
L/A Ratio	>7.72	0.717	63.16	78.57	94.1	28.2

ROC curve=Receiver operating characteristic curve, AUC= Area under curve

Table 6: Cut off values for serum leptin level, adiponectin and L/A ratio to differentiate between the CM risk group and the non-CM risk group after dietary management.

Variable after dietary management	Cut off point	AUC	Sensitivity	Specificity	+PV	-PV
Serum Leptin	>21.39	0.800	75.00	78.57	95.0	36.7
Serum Adiponectin	≤4.5	0.834	73.68	85.71	96.6	37.5
L/A ratio	>4.64	0.868	81.58	85.71	96.9	46.2

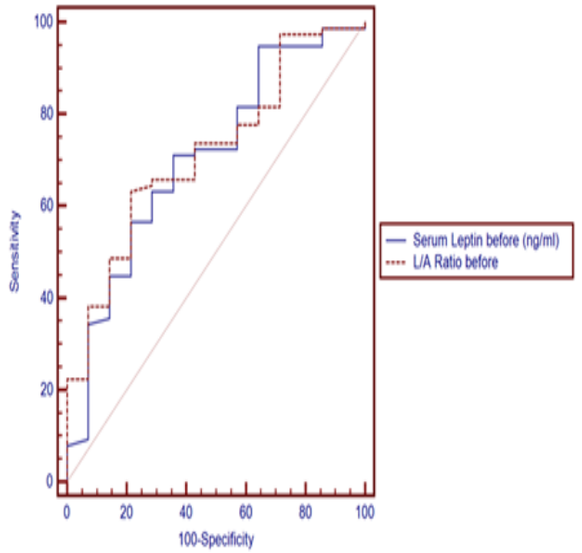

Fig. 3: Receiver operating characteristic (ROC) curve for leptin and L/A ratio before dietary management

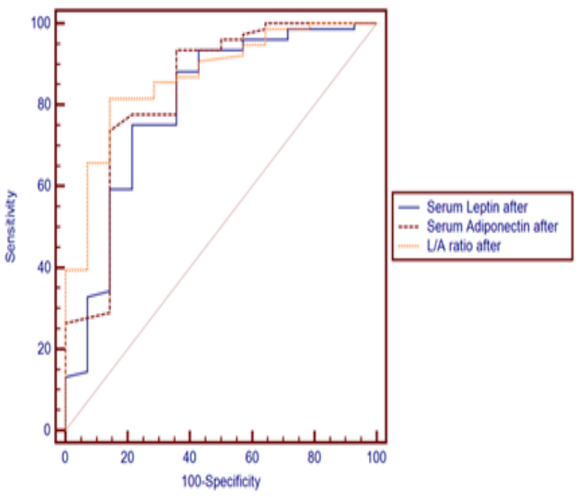

Fig. 4: ROC curve for leptin, Adiponectin and L/A ratio after dietary management.

DISCUSSION

This study aimed to evaluate the prognostic value of serum concentrations of the adipokines (total leptin and adiponectin as well as the L/A ratio) in children and adolescents with simple obesity under nutritional management program and its role in developing cardio-metabolic complications.

Before management, on comparing the two groups we realized that there was a significant higher value of leptin and L/A ratios in the CM risk group in comparison to the non-CM risk group with *P values* 0.017 and 0.010, respectively. Similarly, after management leptin and L/A ratios showed significantly higher serum levels in the CM risk group in comparison to the non-CM risk group. Although, Adiponectin showed significant lower serum level in the CM risk group in comparison to the non-CM risk group after management with *p value* <0.001, the serum levels of Adiponectin were comparable between both groups before management.

On checking ROC curve before management, on assessing the ability to differentiate between CM risk and non-CM risk groups leptin showed a higher sensitivity than L/A ratio but higher specificity is noticed with L/A ratio. But after management L/A ratio showed a higher sensitivity and specificity than leptin and adiponectin. Upon these findings we can consider that L/A ratio is more valuable predictor in assessing pediatric obesity and its cardiometabolic risk factors and complications more than leptin and/or adiponectin alone.

In agreement with these results, ***Adejumo et al.***, 2019 revealed that L/A ratio is a better marker for predicting the risk of metabolic syndrome than leptin and adiponectin alone in both sexes[16]. This finding was similar to what was reported in a prospective study from China where the AUC for L/A ratio was larger than adiponectin and leptin[16].

Cross sectional studies from China and sub-Saharan Africa also suggested L/A ratio to be better predictor of metabolic syndrome than adiponectin and leptin. High adiponectin and low leptin levels could offer some protection against the development of metabolic syndrome. High leptin has shown to be associated with vascular injury, hypertension and atherosclerosis while high adiponectin levels are said to have anti-inflammatory and protective effects against them[16].

The correlation between adipokines imbalance, IR markers and CM comorbidities has been demonstrated revealing L/A ratio as a better marker of obesity related comorbidities. And so, suggesting that L/A ratio as a marker is superior to both adiponectin and leptin alone[7].

Similarly, another study has examined the impact of the L/A ratio on weight gain from childhood to adolescence revealing that the L/A ratio may be a more efficient predictor of obesity and related complications than leptin or adiponectin alone[17].

Based on our study findings and the strong association between adipokines and obesity considering its risk factors and complications. We state that identifying serum adipokines would be promising and beneficial for the

optimum assessment of obesity and its severity specially the L/A ratio which has been found to be superior to leptin and adiponectin alone. Providing a simple, easy, and cost-effective approach for early detection and prompt treatment of metabolic syndrome as a complication of obesity.

So, the evaluation of this ratio in obese children will allow the prediction of those who will develop CM complications and to be candidates for prevention and early intervention plans to reduce the morbidity and complications of childhood obesity.

Data availability

The data sets generated and /or analyzed during current study are available from the corresponding author on reasonable request.

AUTHORS CONTRIBUTION STATEMENT

Nadin N toaima: Concept and design of the study, revised the data, shared in writing the paper draft and critically revised the manuscript before submission, final approval of the script. Agrees to be accountable for all aspects of the work and is the corresponding author.

Hussien F Wanas: Collected the data, wrote the manuscript draft and agrees to be accountable for all aspects of the work.

Sara I Abdellfattah: Analyzed the data, shared in writing and revised the manuscript critically and agrees to be accountable for all aspects of the work.

Haya E Ibrahim: revised and analyzed the data, and wrote the manuscript draft. Agrees to be accountable for all aspects of the work.

Department/ Institute to which the work should be attributed: Children's Hospital- Pediatric Department- Faculty of Medicine- Ain Shams university- Cairo- Egypt

CONFLICT OF INTERESTS

There is no conflicts of interest.

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القدرة التنبؤية للنسبة بين هرمون اللبتين والأديبونكتين في حدوث مخاطر مضاعفات القلب في أطفال ومراهقي السمنة المفرطة: قبل وبعد العلاج الغذائى

نادين نبيل طعيمة[1]، حسين فؤاد ونس[2]، سارة ابراهيم طه[3] و هيا عصام ابراهيم[4]

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المقدمة: تفرز الأنسجة الدهنية العديد من الأديبوكينات التي تلعب أدوارًا أساسية في تنظيم التمثيل الغذائي. ومن هذه الأديبوكينات اللبتين والأديبونيكتين، اللذان ينظمان وزن الجسم واستهلاك الطاقة. نظرًا لأن اللبتين والأديبونيكتين يتغيران عكسيًا بالنسبة لمؤشر كتلة الجسم، فقد تم اقتراح النسبة بينهما -الليبتين إلى الأديبونيكتين- كعلامة أكثر حساسية لمتلازمة التمثيل الغذائي من تركيزاتهما بالدم بشكل منفرد كل منهما على حدة.

الهدف: تقييم القدرة التنبؤية لتركيزات الأديبوكينات في الدم (الليبتين، الأديبونيكتين، والنسبة بينهما) لدى الأطفال والمراهقين الذين يعانون من السمنة البسيطة أثناء الخضوع لبرنامج تغذية ودورهم في حدوث وتطور مخاطر مضاعفات القلب والتمثيل الغذائي.

طرق البحث: أجريت هذه الدراسة على ٩٠ طفل ومراهق (العمر: ٦-١٨ سنة) مصابين بالسمنة البسيطة من عيادة السمنة بمستشفى الأطفال جامعة عين شمس. تم إخضاع جميع المرضى بداية وبعد ٦ أشهر من البرنامج الغذائي لما يلي: التاريخ الطبي، القياسات الجسمانية، تحليل مكونات الجسم، النظام الغذائي على مدار الأربع والعشرون ساعة السابقة للفحص والفحوصات المخبرية بما في ذلك: الدهون والجلوكوز والأنسولين واللبتين والأديبونيكتين وتقييم نموذج التوازن لمقاومة الأنسولين.

النتائج: كشفت عن قيم أعلى لنسبة هرمون الليبتين في الدم والنسبة بين اللبتين إلى الأديبونكتين في المجموعة ذات المخاطر القلبية الأيضية قبل وبعد النظام الغذائي مقارنة بالمجموعة غير ذات المخاطر القلبية الأيضية. بعد النظام الغذائي، تم العثور على مستويات قليلة من الأديبونيكتين في المجموعة ذات المخاطر القلبية الأيضية. وقبل النظام الغذائي، أظهر منحنى خاصية تشغيل المستقبل أن أفضل نقطة قطع لنسبة اللبتين الي الأديبونكتين للتمييز بين المجموعة ذات المخاطر القلبية الأيضية والمجموعة غير ذات المخاطر القلبية الأيضية تم العثور عليها كانت >٧,٧٢ مع حساسية ٦٣,١٦٪، ونوعية ٧٨,٥٧٪ ومساحة تحت المنحني ٧١,٧٪. بعد النظام الغذائي، أظهر منحنى خاصية تشغيل المستقبل أن أفضل نقطة قطع كانت >٤,٦٤ مع حساسية ٨١,٥٨٪، ونوعية ٨٥,٧١٪ ومساحة تحت المنحني ٨٦,٨٪.

الاستنتاج: بناء على هذه النتائج، فإن تحديد نسبة هرمون الليبتين / الأديبونيكتين في الدم سيكون أداة واعدة ومفيدة للتقييم الأمثل للسمنة وشدتها.