Association of metabolic syndrome components and hepatic transaminases with indicators of dimension and body composition in pediatric-aged subjects

Asociación de los componentes del Síndrome Metabólico y las transaminasas hepáticas con indicadores de dimensión y composición corporal en sujetos pediátricos

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Abstract

Objective. To determine the association of metabolic syndrome components and hepatic transaminases with indicators of dimension and body composition in children and adolescents. **Method**. Descriptive and cross-sectional study with a sample of 776 subjects, who underwent an integral evaluation that included: clinical (blood pressure), anthropometric (body size and composition indicators) and biochemical (plasma lipids, hepatic transaminases and basal glycemia) measures. Statistical analysis was performed with the SPSS version 20.0 statistical package, the results were expressed as median and probable error. Results. Statistically significant differences were found between obese and normal according to BMI, for all the variables analyzed with the exception of height, basal glycemia, LDL-c and AST; correlation of the anthropometric parameters of body dimension and compassion with the components of metabolic syndrome and ALP, additionally statistically significant differences were observed in the levels of the components of metabolic syndrome and hepatic transaminases for the different diagnoses of the body composition indicators. **Conclusion**: the results suggest that anthropometric variables and ALT are related to the components of the MS; therefore, they could be incorporated as a useful tool, due to their accessibility and low cost, in clinical practice.

Keywords: ALP; adolescents, anthropometry, metabolic syndrome components.

Resumen

Objetivo. Determinar la asociación de los componentes del síndrome metabólico y las transaminasas hepáticas con indicadores de dimensión y composición corporal en niños y adolescentes. **Método.** Estudio descriptivo y transversal con una muestra de 776 sujetos, a los que se les realizó una evaluación integral que incluyó: medidas clínicas (presión arterial), antropométricas (indicadores de dimensión y composición corporal) y bioquímicas (lípidos plasmáticos, transaminasas hepáticas y glucemia basal). El análisis estadístico se realizó con el paquete estadístico SPSS versión 20.0, los resultados se expresaron como mediana y error probable. Resultados. Se encontraron diferencias estadísticamente significativas entre obesos y normales según el IMC, para todas las variables analizadas a excepción de la estatura, la glucemia basal, el LDL-c y la AST; correlación de los parámetros antropométricos de dimensión corporal y compasión con los componentes del síndrome metabólico y la ALP, además se observaron diferencias estadísticamente significativas en los niveles de los componentes del síndrome metabólico y las transaminasas hepáticas para los diferentes diagnósticos de los indicadores de composición corporal. **Conclusión**: los resultados sugieren que las variables antropométricas y la ALT están relacionadas con los componentes del SM, por lo que podrían incorporarse como una herramienta útil, por su accesibilidad y bajo coste, en la práctica clínica.

Palabras clave: ALP; adolescentes, antropometría, componentes del síndrome metabólico, obesidad, obesidad.

Introduction

Metabolic syndrome (MS) is related to a series of inflammatory, metabolic, and vascular alterations associated with the development of insulin resistance (IR), type 2 diabetes (DM2) and atherosclerotic cardiovascular disease (ACD). However, there are other clinical and biochemical changes involved that are not considered because they are not yet part of the routine medical-diagnostic protocol in public or private hospitals, such as: microalbuminuria, acanthosis nigricans, non-alcoholic fatty liver disease (elevated liver transaminases), hyperuricemia, obesity, and gallstones[1,2].

For some years now, the association between the components of MS, anthropometric indicators of both dimension and body composition and the increase in the levels of glutamic-pyruvic (GPT) and glutamic-oxaloacetic (GOT) transaminases has been proposed. Regarding anthropometric parameters, their determination should include standardized measurements of height, weight, waist circumference and some authors also propose hip circumference, applying specific percentiles according to age and gender[3].

Although this indicator does not distinguish between fat and muscle mass, it correlates strongly with alterations in plasma lipids, hyperinsulinemia, and high blood pressure, all of which are considered cardiovascular risk factors and in turn components of MS. On the other hand, in recent years the waist-height index has been used to define abdominal obesity and visceral fat deposits in children and adolescents, due to its close relationship with cardiometabolic risk, which makes the use of both indicators advisable[3,4,5].

In relation to biochemical parameters, elevated ALP is considered a marker of endothelial damage specific to liver cells and is described in some meta-analyses as a dual risk factor for DM2 and MS.[6]. The enzymatic alterations are manifested with more severity and magnitude when the individual is obese; however, in pediatric age the evidence found has not been sufficient. On the other hand, for some researchers, non-alcoholic hepatic steatosis represents the hepatic manifestation of MS and, due to the obesity epidemic, it is currently considered the most frequent form of chronic liver disease in children[7,8].

In obese individuals, there can be a progressive apparition of the alteration of the criteria usually considered in the diagnosis of MS from childhood and prevail until adulthood. Therefore, the evaluation of the above-mentioned biochemical indicators could be beneficial because it would allow the early detection of molecular alterations that precede the appearance of the clinical signs of the disease. These tests and the anthropometric measurements are easy and inexpensive to perform[9, 10], so this research aims to determine the association of the components of MS and hepatic transaminases with indicators of dimension and body composition in pediatric age subjects.

Materials and methods

A total of 776 children and adolescents (375 male subjects), selected by random sampling, with a median age of 12.00 (3.0) years, were included in this descriptive, cross-sectional, field study, after signature of the informed consent by their legal representatives. The data collection was carried out during the Integral Evaluation Days of the Research Program "Genetic and Metabolic Factors Implicated in the Risk for Atherosclerosis in children and adolescents of the Maracaibo Municipality", conducted by a multidisciplinary team of professionals assigned to the Endocrine-Metabolic Research Center "Dr. Félix Gómez" (Centro de Investigaciones Endocrino-Metabólicas "Dr. Félix Gómez", CIEM by its acronym in Spanish) of the Faculty of Medicine of the Universidad del Zulia, Maracaibo, Zulia State, Venezuela; carried out during the years 2012 to 2016, according to the procedures of the Declaration of Helsinki and approved by the Bioethics Committee of CIEM.

The parents and legal representatives of the children and adolescents were invited to participate by written communication where they were also informed about the objectives and scope of the project. Each participant underwent a comprehensive evaluation that included clinical, anthropometric, and biochemical assessments.

Clinical assessment: consisted of a general physical examination by a pediatrician, which included interviewing the child or adolescent, with the help of his or her representative, and taking systolic blood pressure (SBP) and diastolic blood pressure (DBP), which was performed twice at 5-minute intervals, following standardized international procedures, using the IDF criteria for MS for children and adolescents as reference values[11].

Anthropometric evaluation: it was performed by a dietitian-nutritionist, and included variables of body dimension and composition following standardized techniques[12]. Weight was assessed using a total body composition analyser and a digital scale (Tanita, TBF-310 GS Body Composition Analyzer, Tokyo, Japan). Height was obtained with a calibrated rod in centimetres and millimetres with the patients shoeless and wearing light clothing. The participant's head was aligned in the Frankfort horizontal plane, and once correctly positioned, a headboard was firmly placed on top of the head with sufficient pressure to compress the hair

to "capture" the height. The individual values were compared with the percentiles constructed for the population of Maracaibo[13]. Waist circumference (WC) was measured with a plastic tape measure graduated in centimetres at a point equidistant between the costal edge and the anterior superior iliac spine at the end of a normal expiration, with the arms relaxed at the sides. Body Mass Index (BMI) was calculated by Quetelet's equation [weight/height2], and the results were expressed in kg/m2, which was taken to the World Health Organization (WHO) graphs adapted to the Venezuelan population[14] to establish the anthropometric nutritional status of the children (normal between -2 and 1 z-score, overweight between 1 and 2 z-score, obese over 2 z-score and severely obese over +3 z-score) (WHO). The waist-to-height ratio (WHtR) was calculated using as reference values those proposed by Marrodan et al.[15].

The triceps skinfold (TSK) was performed using a LANGE caliper[12] and for the brachial circumference (BC) a non-distensible tape measure (normal> p10 and£ p90, high> p90)[12, 16]. By means of Frisancho's formulas, the muscle area (MA) was calculated[13, 15, 17] the muscular area (MA) and body fat area (FA) were calculated (normal> p10 and£ p90, overweight or obese> p90),[16]. By means of bioelectrical impedance with TANITA model TBF 300 GS - TBF MA equipment, body composition was determined, specifically the percentage of fat mass (%FM),[18], fat mass (FM), and lean mass (LM)[18]. The cut-off points were low (< p2), normal (≥p2 and < p85), overweight (≥p85 and < p95) and obese (≥p 95).[19]

Biochemical assessment. After a 12-hour fast, a blood sample was taken from all participants to quantify glucose, transaminases, and plasma lipid levels. Basal glucose (BG), triacylglycerides (TG), total cholesterol (TC), high-density lipoprotein cholesterol (HDL-c), and ALP and AST transaminases were determined using colorimetric enzymatic methods (brand name HUMAN Gesellschatf fur Biochemica und Diagnostica mbH Germany). Cholesterol associated with low- density lipoprotein cholesterol (LDL-c) was calculated with the Friedwald formula (LDL= Total cholesterol - HDL-c + (Triglycerides/5).[20]

Statistical analysis

Statistical analysis was performed using SPSS version 20.0 for Windows (SPSS Inc., Chicago, IL). Values were expressed as median and probable error (PE); PE is calculated as the difference of quartiles 3 (Q3) minus one (Q1), divided by 2 (Q3 -Q1/2). The distribution of the variables was verified using the Kolmogorov- Smirnov test. Comparison between groups was determined by the Mann-Whitney U test. Partial correlation was used, with gender as a control variable, to establish the association between the components of MS, liver transaminases, and body dimension and composition indicators. Statistically significant differences and associations were considered at p values (< 0.05).

Results

Table 1 shows the anthropometric, biochemical, and clinical characteristics of the subjects evaluated, according to the anthropometric diagnosis by BMI; all the variables showed statistically significant differences between the obese and normal groups, except for height, BG, LDL-c and AST.

Table 1. Demographic, anthropometric, biochemical and clinical characteristics of the subjects evaluated accordingto their BMI

	ALL		NORMAL		OBESE		
	n=776		n=524		n=252		
	Median	EP	Median	EP	Median	EP	p
Age (years)	12,0	3,0	12,0	3,0	12,0	3,0	0,000
Weight (kg)	48,1	63,5	42,0	29,4	65,8	57,1	0,000
Size (mts)	1,5	0,4	1,5	0,3	1,5	0,3	0,101
BMI	19,6	20,9	17,9	6,1	27,9	20,9	0,000
TSK (mm)	15,6	17,6	12,0	15,6	25,0	13,5	0,000
AC (cm)	25,0	34,5	23,0	24,3	31,0	29,3	0,000
WC (cm)	71,1	57,0	66,0	33,3	92,5	39,8	0,000
WHtR	0,5	0,3	0,4	0,2	0,6	0,2	0,000
%FM	22,1	38,2	15,1	38,2	37,1	22,9	0,000
FM (kg)	10,4	45,7	6,3	19,9	24,0	41,9	0,000
LM (kg)	36,2	38,3	33,7	30,0	40,7	31,6	0,000
AM (mm^2)	3236,8	18977,9	2812,8	12289,2	4391,5	18334,2	0,000
FA (mm^2)	1707,2	6572,1	1265,8	2434,0	3419,2	5969,9	0,000
SBP (mmHg)	100,0	45,0	100,0	36,5	110,0	40,0	0,000
DBP (mmHg)	60,0	30,0	60,0	25,0	70,0	25,0	0,000
BG (FM/dL)	85,0	32,8	85,0	31,5	84,0	25,4	0,140
TC (FM/dL)	149,0	105,5	143,9	95,5	157,0	105,5	0,000
TG (FM/dL)	72,4	248,2	60,9	167,3	105,1	244,0	0,000
LDL-c (FM/dL)	89,0	89,2	87,1	78,4	91,2	88,7	0,060
HDL-c (FM/dL)	41,6	38,5	43,0	35,5	39,0	37,2	0,000
AST (U/L)	19,8	75,9	19,6	36,3	20,0	75,3	0,096
ALP (U/L)	12,3	85,8	11,2	60,5	15,6	85,8	0,000

Values expressed as median (EP). p= statistical significance, p£ 0.05 using the Mann and Whitney U test. BMI= Body Mass Index. TSK= triceps skinfold, AC= arm circumference, WC= waist circumference, WHtR= waist/height ratio, %FM= fat mass percentage, FM= fat mass, LM= lean mass, BG= basal blood glucose, TC= total cholesterol, TG= triacylglycerides, LDL-c= low-density lipoprotein cholesterol, HDL-c= high-density lipoprotein cholesterol, UA= uric acid, AST= aspartate aminotransferase, ALP= alanine aminotransferase, SBP= Systolic Blood Pressure. DBP= Diastolic Blood Pressure.

Table 2 shows the partial correlation of the components of the metabolic syndrome and liver transaminases with the indicators of body size and composition of the pediatric subjects evaluated, using gender as a control variable. BG presents a statistically significant and inverse partial correlation with most of the indicators of body size and composition, except for FM and FA. TC presents a statistically significant and direct partial correlation with the following variables: weight, TSK, BC, WC, BMI, WHtR, % FM, FM, and FA. TG, ALP, SBP and DBP show direct and statistically significant partial direct correlations with all the indicators of body dimension and composition; on the contrary, HDL-c presents statistically significant inverse partial correlation with the same variables. ALP only presented a direct and statistically significant partial association with WC, WHtR, and FM. Finally, LDL-c had a direct and statistically significant partial correlation with TSK, WC, WHtR, % FM, FM, and FA.

Table 3 summarizes the behavior of the components of MS and liver transaminases of all the subjects evaluated, according to the anthropometric diagnosis of each of the indicators of body size and composition. The levels of BG, were significantly different when comparing the groups according to the diagnosis of each of the following anthropometric variables: WC, WHtR, AC/A, %FM and MA/A. The TG as well as HDL-c, SBT, DBP and ALP show statistically significant differences when contrasting the groups according to the diagnosis of each indicator, for all the anthropometric variables, however, the AST does not show the same behavior.

Table 2. Partial correlation of metabolic syndrome components and hepatic transaminases with body size and composition indicators of the subjects evaluated

n 773		Weight (kg)	Size (mts)	TSK (mm)	AC (cm)	WC (cm)	BMI	WHtR	%FM	FM (kg)	LM (kg)	AM (mm^2)	FA (mm^2)
BG (FM/dL)	r	-0,08	-0,07	-0,13	-0,09	-0,10	- 0,08	- 0,09	-0,08	-0,05	-0,08	-0,03	-0,11
	p	0,03	0,04	0,00	0,01	0,00	0,03	0,01	0,03	0,16	0,02	0,47	0,00
TC (FM/dL)	r	0,09	-0,11	0,22	0,12	0,16	0,16	0,22	0,21	0,18	-0,05	0,05	0,19
	p	0,02	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,18	0,20	0,00
TG (FM/dL)	r	0,39	0,09	0,43	0,38	0,46	0,47	0,46	0,44	0,45	0,23	0,22	0,43
	p	0,00	0,02	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
HDL-c (FM/dL)	r	-0,23	-0,24	-0,11	-0,21	-0,21	- 0,19	- 0,14	-0,13	-0,17	-0,26	-0,16	-0,16
	p	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
LDL-c (FM/dL)	r	0,02	-0,07	0,12	0,06	0,08	0,07	0,12	0,11	0,09	-0,06	0,03	0,10
	p	0,53	0,04	0,00	0,08	0,02	0,06	0,00	0,00	0,01	0,10	0,48	0,01
SBP (mmHg)	r	0,60	0,40	0,44	0,51	0,53	0,55	0,42	0,46	0,51	0,54	0,34	0,49
	p	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
DBP (mmHg)	r	0,18	0,10	0,18	0,17	0,17	0,19	0,15	0,17	0,17	0,15	0,10	0,18
	p	0,00	0,01	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,01	0,00
AST (U/LI)	r	0,05	-0,06	0,02	0,04	0,07	0,07	0,09	0,07	0,10	-0,04	0,04	0,04
	p	0,17	0,10	0,58	0,25	0,04	0,06	0,01	0,05	0,00	0,23	0,22	0,27
ALP (U/L)	r	0,28	0,07	0,22	0,23	0,29	0,29	0,28	0,27	0,31	0,15	0,16	0,24
	p	0,00	0,04	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

r=Partial correlation using gender as control variable, p= statistical significance p 0.05. BG= Basal Glucose TSK=triceps skinfold, AC=arm circumference, WC=waist circumference. BMI= Body Mass Index WHtR= waist-to-height ratio, %FM= percentage of fat mass, FM= fat mass, LM= lean mass, BG= basal glycemia, TC= total cholesterol, TG= triacylglycerides, LDL-c= low density lipoprotein cholesterol, HDL-c= high density lipoprotein cholesterol, UA= uric acid, AST= aspartate aminotransferase, ALP= alanine aminotransferase, SBP= Systolic Blood Pressure. DBP= Diastolic Blood Pressure.

Behavior of the components of the metabolic syndrome and transaminases according to anthropometric diagnosis of the subjects evaluated.

ALL (n = 776)								
				Components			Transaminases	
Indicators	Diagnostics (n)	BG (FM/dL)	TG (FM/dL)	HDL-c (FM/dL)	SBP(mmHg)	DBP(mmHg)	ALP(U/L)	AST(U/L)
BMI	Normal (524)	85 (31,5)	60,9 (167,3)[a]	43 (35,5)[a]	100,6 (36,5)[a]	60 (25)[a]	11,2 (60,5)[a]	19,6 (36,3)
	Obese (252)	84 (25,4)	105,1 (244)[a]	39 (37,2)[a]	110 (40)[a]	70 (25)[a]	15,6 (85,8)[a]	20 (75,3)
WC (cm)	Normal (570)	85,48(32,8)[a]	65 (190)[a]	43 (32,5)[a]	100 (40)[a]	60 (25)[a]	11,5 (60,5)[a]	19,62 (36,3)
	High (190)	83 (23,3)[a]	108,5(243,9)[a]	39 (37,2)[a]	110 (40)[a]	70 (25)[a]	16,15 (85,8)[a]	19,95 (75,3)
WHtR	Normal (487)	85,52(31,4)[a]	59,61 (99)[a]	44 (35,5)[a]	100 (36,5)[a]	60 (22,5)[a]	11,03 (60,5)[a]	19,9 (36,28)
	High (289)	83,57(25,6)[a]	101,5(245,7)[a]	39 (37,2)[a]	110 (40)[a]	70 (25)[a]	15 (85,6)[a]	19,42 (75,9)
AC/A	Normal (430)	86 (31,2)[a]	60,1 (152)[a]	44 (34,5)[a]	100 (35)[a]	60 (22,5)[a]	11,1 (60,5)[a]	19,8 (36,3)
	High (275)	83,6 (27)[a]	99 (231,6)[a]	39 (37,2)[a]	110 (40)[a]	70 (25)[a]	14,3 (84,8)[a]	19 (75,9)
	Normal (275)	85 (27)[a]	68,7 (118)[ac]	42 (33,2)[c]	100(36,5)[c]	60(25)[ac]	11,6(27,3)[ac]	19 (36,3)
%FM	Overweight (160)	82,9 (24,3)[a]	79,6(245,7)[ab]	40(34)	100(35)[b]	70(20)[ab]	13(34,3)[ab]	19(17,7)
	Obese (135)	84,2(21,5)	117,5(229,9)[bc]	39(29,3)[c]	110(40)[bc]	70(25)[bc]	16(84,7)[bc]	19(75)
	Normal (349)	84,7(27)	67,8(118)[ab]	43(28)[ab]	100(36,5)[ab]	60(25)[ab]	11,5(28,4)[ab]	19(36,3)
FM (Kg)	Overweight (79)	82,7(20,8)	89,6(169)[ac]	40(37,2)[a]	100(25)[ac]	70(20)[ac]	14(35,5)[ac]	19,9(17,1)
	Obese (147)	84,2(21,5)	117(24,4)[bc]	38,1(27,7)[b]	110(40)[bc]	70(25)[bc]	16,8(84,7)[bc]	19,1(75)
	Normal (601)	85(32,8)	68(190)[ab]	42(37,2)[b]	100(40)[ab]	60(29)[ab]	12(60,5)[ab]	19,8(36,3)
LM (Kg)	Overweight (75)	84(19,8)	109(180,8)[a]	41(25,4)	110(35)[ac]	70(20)[ac]	14(39,8)[a]	19,1(40,7)
	Obese (55)	83,2(17,7)	109,3(244,6)[b]	36,5(20,3)[b]	120(35)[bc]	70(20)[bc]	16(85,8)[b]	19(73,7)
MA/A	Normal (470)	85,8 (32,8)[a]	65 (190)[a]	43 (31)[a]	100 (35)[a]	60 (25)[a]	11,6 (60,5)[a]	19,5 (26,3)
	High (222)	83,1 (24,9)[a]	104,1(244,6)[a]	38,9(37,2)[a]	110 (40)[a]	70 (30)[a]	15 (84,7)[a]	19,7 (75)
FA/A	Normal (501)	85 (31,5)	61 (167,3)[a]	43 (32,5)[a]	100 (36,5)[a]	60 (25)[a]	11,3 (60,5)[a]	19,9 (36,3)
	High (240)	84 (25,4)	106,7(244,2)[a]	39 (37,2)[a]	110 (40)[a]	70 (25)[a]	15 (84,7)[a]	19,1 (75,9)

Expressed in Median (probable error). BMI= Body Mass Index. WC/A= waist circumference/age, WHtR= waist-to-height ratio, AC/A= arm circumference/age, %FM= percentage of fat mass, FM= fat mass, LM= lean mass, MA/A= muscle area/age; FA/A= fat area/age; AST= Aspartate Aminotransferase. ALP= Alanine Aminotransferase SBP= Systolic Blood Pressure. DBP= Diastolic Blood Pressure. BG= basal glycemia, TG= triacylglycerides, HDL-c = high density lipoproteins. Equal symbols in the column indicate significant difference for different categories of the parameter determined by the (a,b,c) Mann and Whitney U test.

Tables 4 and 5 compare the levels of the different components of MS and liver transaminases between the diagnostic groups for each of the indicators of body size and composition in male and female subjects. In females, there were no significant differences in the levels of WBC between the diagnostic groups for the anthropometric variables analyzed, while in the male gender, differences were observed with the exception of the variables BMI, FM and LM. HDL-c in the female gender showed significant variation in its levels between the diagnostic groups for all the anthropometric indicators analyzed; however, in the male gender these differences could not be observed between the diagnostic groups for the %FM and FM indicators.

Behavior of the components of the metabolic syndrome and transaminases according to the anthropometric diagnosis of the male subjects evaluated.

MALE (n = 375)								
				Components			Transaminases	
Indicators	Diagnostics (n)	BG (FM/dL)	TG (FM/dL)	HDL-c (FM/dL)	SBP(mmHg)	DBP(mmHg)	ALP(U/L)	AST(U/L)
BMI	Normal (236)	87 (26,7)	52,15 (99)^{a}	42 (34,5)^{a}	100 (31,5)^{a}	60 (22,5)^{a}	11,59 (60,5)^{a}	20,72 (36,26)
	Obese (139)	84,9 (25,4)	102,1 (243,2)^{a}	40 (35,9)^{a}	110 (35)^{a}	70 (25)^{a}	16,31 (85,8)^{a}	20,71 (74,8)
WC (cm)	Normal (272)	87,12(30,2)^{a}	58,2 (190)^{a}	42 (31,5)^{a}	100 (35)^{a}	60 (25)^{a}	12 (60,5)^{a}	20,63 (36,26)
	High (93)	82,65(21,3)^{a}	106 (241,6)^{a}	39 (35,9)^{a}	110 (35)^{a}	70 (25)^{a}	17 (85,8)^{a}	21,3 (74,8)
WHtR	Normal (225)	87 (26,6)^{a}	52 (99)^{a}	43 (34,5)^{a}	100 (31,5)^{a}	60 (22,5)^{a}	11,6 (60,5)^{a}	21 (35,9)
	High (150)	84,9 (25,4)^{a}	100,05(243,2)^{a}	39,15 (35,9)^{a}	110 (35)^{a}	70 (25)^{a}	15,69 (85,8)^{a}	20,07 (75,9)
AC/A	Normal (215)	87,3 (26,7)^{a}	52 (101,1)^{a}	42 (34,5)^{a}	100 (30)^{a}	60 (22,5)^{a}	12 (60,5)^{a}	20,82 (35,4)
	High (126)	84,2 (25,4)^{a}	99,5 (229,1)^{a}	38,1 (35,9)^{a}	110 (35)^{a}	70 (25)^{a}	15,21 (84,8)^{a}	19,05 (75,9)
%FM	Normal (144)	86(23,1)^{a}	69,9(108)^{ab}	40(33,2)	100(31,5)^{b}	65(25)^{ab}	12,3(27,3)^{ab}	19,1(36,3)^{b}
	Overweight (53)	84,1(17,6)^{a}	101,3(241,7)^{a}	39,3(19,9)	110(25)^{c}	70(20)^{a}	15,5(18,4)^{ac}	20,2(15,3)
	Obese (43)	83,8(18,5)	130,7(223,6)^{b}	39(29,3)	110(35)^{bc}	70(25)^{b}	20,9(82,5)^{bc}	22,7(71,2)^{b}
FM (Kg)	Normal (139)	86(23,1)	66,6(108)^{ab}	41(24)	100(31,5)^{ab}	65(25)^{ab}	12(26,3)^{ab}	19,2(36,3)^{b}
	Overweight (56)	84,2(20,8)	101,1(166,2)^{a}	39,7(33,2)	110(20)^{ac}	70(20)^{ac}	14(20,5)^{ac}	19,1(15,3)^{c}
	Obese (52)	83,5(19,5)	109,7(241,7)^{b}	39(25,8)	110(35)^{bc}	70(20)^{bc}	22,3(82,5)^{bc}	24(73,7)^{bc}
LM (Kg)	Normal (286)	85,9(30,2)	62,7(190)^{ab}	42(33,2)^{b}	100(35)^{ab}	65(29)^{ab}	12,6(60,5)^{b}	20,7(36,3)
	Overweight (33)	84,3(17,8)	93(180,8)^{a}	41(20,5)	110(20)^{a}	70(20)^{a}	14,8(39,8)	21(19,5)
	Obese (33)	82(17,4)	101,3(244,6)^{b}	37(20,3)^{b}	110(25)^{b}	70(20)^{b}	16(85,8)^{b}	19,1(73,7)
MA/A	Normal (219)	87,4 (30,2)^{a}	58,3 (190)^{a}	42 (29)^{a}	100 (30)^{a}	60 (25)^{a}	12 (60)^{a}	20,2 (26,3)^{a}
	High (105)	83,1 (21,3)^{a}	101,5(244,6)^{a}	39 (35,9)^{a}	110 (35)^{a}	70 (30)^{a}	16,3 (84,3)^{a}	21 (74,8)^{a}
AG/A	Normal (228)	87,1 (26,7)^{a}	52,2(110,9)^{a}	43 (31,5) ^{a}	100 (31,5)^{a}	60 (25)^{a}	12 (60,5)^{a}	20,7 (35,4)
	High (134)	84 (25,4)^{a}	101,8(243,2)^{a}	39 (35,9)^{a}	110 (35)^{a}	70 (25)^{a}	16,8 (84,7)^{a}	20,5 (75,9)

Expressed in Median (probable error). BMI= Body Mass Index. WC/A= waist circumference/age, WHtR = waist-to-height ratio, AC/A= arm circumference/age, %FM= percentage of fat mass, FM= fat mass, LM= lean mass, MA/A= muscle area/age; FA/A= fat area/age; AST= Aspartate Aminotransferase. ALP= Alanine Aminotransferase SBP= Systolic Blood Pressure. DBP= Diastolic Blood Pressure. BG= basal glycemia, TG= triacylglycerides, HDL-c= high density lipoproteins, UA= uric acid. Equal symbols in the column indicate significant difference for different categories of the parameter determined by the (a,b,c) Mann and Whitney U test.

Behavior of the components of the metabolic syndrome and transaminases accordingto anthropometric diagnosis of the female subjects evaluated

		FEMALE (n = 400)						
				Components			Transaminases	
Indicators	Diagnostics (n)	BG (FM/dL)	TG (FM/dL)	HDL-c (FM/dL)	SBP(mmHg)	DBP(mmHg)	ALP(U/L)	AST(U/L)
BMI	Normal (287)	84,4 (31,5)	66,0(164,8)^{a}	44 (29)^{a}	95 (30)^{a}	60 (25)^{a}	11 (36,9)^{a}	18,9 (24,28)
	Obese (113)	83,2 (21)	112,4(202,9)^{a}	38 (34)^{a}	110 (40)^{a}	70 (20)^{a}	15 (53,4)^{a}	19 (40,7)
WC (cm)	Normal (298)	84,5 (31,5)	70,4(149,5)^{a}	43,5 (31)^{a}	100 (35)^{a}	60 (25)^{a}	11,06 (36,96)^{a}	19 (24,28)
	High (97)	83,15 (21)	112,4(202,9)^{a}	38,1(28,9)^{a}	110 (40)^{a}	70 (20)^{a}	15 (53,4)^{a}	19 (40,7)
WHtR	Normal (261)	84,7(31,5)	65,6(93,8)^{a}	44 (28,5)^{a}	90 (30)^{a}	60 (20)^{a}	11 (28,5)^{a}	18,9 (23,6)
	High (139)	83 (23,5)	104 (204,6)^{a}	38,8(34)^{a}	100 (40)^{a}	70 (20)^{a}	14,75 (53,4)^{a}	19 (40,74)
AC/A	Normal (214)	85 (31,2)	66,2 (149,5)^{a}	45 (27,5)^{a}	90 (30)^{a}	60 (20)^{a}	10,8 (26,4)^{a}	18,9 (23,3)
	High (149)	83,2 (24,8)	99 (204,6)^{a}	39 (34)^{a}	100 (40)^{a}	70 (20)^{a}	13,7 (53,4)^{a}	19 (40,7)
%FM	Normal (131)	83,5(25,4)	66(115,5)^{b}	45(28)^{ab}	95(30)^{ab}	60(20)^{ab}	11(18,9)^{ab}	19(23,6)
	Overweight (107)	82,9(24,3)	74(149,5)^{c}	40(34)^{a}	100(30)^{ac}	65(20)^{ac}	12,2(34,3)^{ac}	18(17,7)
	Obese (92)	84,6(21)	117,3(202,9)^{bc}	38(24,4)^{b}	110(40)^{bc}	70(20)^{bc}	15(53,4)^{bc}	18,9(40,4)
FM (Kg)	Normal (210)	83,7(25,6)	69,4(115,5)^{b}	44(28)^{b}	100(35)^{b}	60(25)^{b}	11(28,4)^{ab}	18,7(23,6)
	Overweight (23)	81,7(14,4)	80(144,7)^{c}	40(34)	100(25)^{c}	65(15)c	14(32,9)^{a}	20(15,7)
	Obese (95)	85(21)	119,3(202,9)^{bc}	38(25,9)^{b}	110(40)^{bc}	70(20)^{bc}	15(53,4)^{b}	19(40,5)
LM (Kg)	Normal (315)	84(31,5)	73(149,5)^{ab}	42(34)^{a}	100(30)^{ab}	60(25)^{ab}	11,7(54,4)^{ab}	19(30,8)
	Overweight (42)	82,8(19)	116,4(157,8)^{a}	40,5(25,4)^{a}	110(35)^{ac}	70(17,5)^{ac}	13,9(34,8)^{a}	17,8(38,9)
	Obese (22)	85(15)	123,2(202,9)^{b}	35,1(15)	120(35)^{bc}	80(15)^{bc}	16,5(12,2)^{b}	19(8,5)
MA/A	Normal (251)	84,7 (31,2)	68,9(149,5)^{a}	44 (31)^{a}	95 (30)^{a}	60 (22,5)^{a}	11,3 (37)^{a}	19 (24,3)
	High (117)	83 (24,9)	107,5(203,3)^{a}	38 (28,9)^{a}	100 (40)^{a}	70 (20)^{a}	14,5 (53,4)^{a}	19 (40,4)
FA/A	Normal (273)	83,6 (31,5)	66,1(164,8)^{a}	44 (29) ^{a}	95 (35)^{a}	60 (25)^{a}	11 (36,9)^{a}	19 (24,3)
	High (106)	84 (21)	113,9(203,1)^{a}	38,5 (34)^{a}	110 (40)^{a}	70 (20)^{a}	14,3 (53,4)^{a}	19 (40,7)

Expressed in Median (probable error). BMI= Body Mass Index. WC/A= waist circumference/age, WHtR= waist-to-height ratio, AC/A= arm circumference/age, %FM= percentage of fat mass, FM= fat mass, LM= lean mass, MA/A= muscle area/age; FA/A= fat area/age; AST= Aspartate Aminotransferase. ALP= Alanine Aminotransferase SBP= Systolic Blood Pressure. DBP= Diastolic Blood Pressure. BG= basal glycemia, TG= triacylglycerides, HDL-c= high density lipoproteins, UA= uric acid. Equal symbols in the column indicate significant difference for different categories of the parameter determined by the (a,b,c) Mann and Whitney U test.

On the other hand, while female AST did not significantly modify its levels when comparing between the diagnostic groups of the different anthropometric variables, in male subjects there were significant changes in its levels of %FM, FM and MA/A indicators. As for the levels of TG, SBP, DBP and ALP, both genders show similar behavior with variation in their levels according to the anthropometric diagnosis of the indicator.

Discussion

The relationship between obesity and MS is well known. These two pathological entities have a high prevalence in our environment and every day is increasing in the pediatric age, which is why the need for tools that show in time who are the subjects most likely to develop them. Therefore, the anthropometric assessment where indicators of dimension and body composition and the assessment of liver enzymes could potentially be useful tools.

Research describes that most of the ALP increases are a consequence of hepatic dysfunction, so this enzyme is not only sensitive, but also very specific of hepatocellular disease (21). The results obtained in this study showed correlation between ALP levels and all anthropometric indicators of body dimension and composition analyzed, coinciding with those reported by Fraser et al. (10) who found an association between ALP, BMI, and WC through a multivariate analysis. Likewise, Loureiro et al. (22) showed, with a multiple regression model, the positive correlation of ALP, BMI and WHtR. The team of Mohammadi et al. (9) team observed in their study that ALT was higher in participants with abdominal obesity, especially with elevated WC and WHtR. Finally, Hartman et al. reported a positive association between BMI and ALT. (23)

On the other hand, Perona et al. (24) reported a correlation in both genders between BMI, CI/T, WC and %FM and the levels of SAD and DBP in their research on anthropometric parameters and the onset of MS in adolescents. Likewise, Rodea-Montero et al. (25) in their study in Mexican adolescents and Ahadi et al. (26) in Iranian children

and adolescents, found an association between the indicators of body size and composition and blood pressure in both genders. All these results coincide with those of this study, which found a correlation between the aforementioned variables using gender as a control variable.

In addition, Ahadi et al. (26) mentioned that for each unit increase in WC and BMI, the risk of elevated DBP increases by 2% and 11%, respectively; similarly, for each unit increase in WC and BMI, the risk of elevated blood pressure increases by 2% and 10%, respectively, and the risk of MS increases by 7% for each unit increase in WC. In addition to the anthropometric parameters already mentioned, this investigation found an association between AC, TSK, %FM, FM, LM, FA, AM and blood pressure.

With respect to the association of plasma lipids with indicators of body size and composition, it is important to note that changes in these parameters, mainly the accumulation of visceral fat, may be early indicators of alteration of lipid variables. (27). In the present study, an inverse correlation was found between HDL-c and all the anthropometric parameters evaluated, as well as TG, LDLc and TC, but in a positive way, especially with the indicators of adiposity.

In the same vein, Oliosa et al. (27) in Brazil, reported associations between plasma lipids and anthropometric variables, observing an inverse relationship between BMI and HDLc in both genders and a positive relationship with LDL-c and TC in men, as well as between WHtR and %FM with TC. Ahadi et al. (26) observed an inverse correlation between HDL-c with WC and BMI and the research group of Hashemipour et al. (28) found a significant association between TC, LDL-c, TG and BG with BMI, WC, and WHtR in Iranian children; however, they did not observe a significant correlation between HDL-c and anthropometric indices.

No recent research shows an association of body composition variables (%FM, FM, LM, AM and FA) with the components of MS in pediatrics. In this study study, a statistically significant correlation was found between the aforementioned body composition indicators and biochemical clinical parameters such as TG, HDL-c, SBP, DBP and ALP. Likewise, statistically significant differences were observed in the levels of the MS components and hepatic transaminases for the different diagnoses of the body composition indicators in the total group, but with variations according to gender. In conclusion, the results obtained suggest that the anthropometric variables of body size and composition and the ALT are related to the components of MS; therefore, they could be incorporated as a useful tool, due to their accessibility and low cost, in clinical practice.

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