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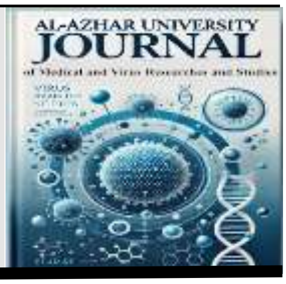

Study of Serum Uric Acid Levels in Obese Children and Adolescents

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Abstract

Obesity in children has become a serious public health issue facing the world today. Serum uric acid is a product of the metabolic breakdown of purine nucleotides; higher serum uric acid levels are an essential risk factor of obesity. Aim of the work is to evaluate serum uric acid levels in association with lipid profile as an indicator of metabolic risk in obese children and adolescents. Patients and methods this observational, cross –sectional study was conducted on one hundred obese children who had BMI ≥ 95th percentile according to CDC criteria, who was recruited from outpatient pediatric clinic in Alzahraa University Hospital in the period from August 2021 to May 2022. All enrolled children were subjected to detailed medical history and clinical examination, besides the following investigation: complete blood count, lipid profile analysis; total serum cholesterol, low- and high-density lipoproteins (LDL&HDL) and serum triglyceride (TG), serum uric acid. Results it was found that obese children experienced higher Z score of BMI, waist circumference, waist/height ratio, systolic blood pressure, diastolic blood pressure, and high serum cholesterol, LDL, TG, serum uric acid and low HDL were observed in obese children. Serum uric acid has a positive correlation with total cholesterol and LDL and a negative correlation with HDL level. Conclusion serum uric acid levels are significantly increased with obesity, and significant correlation with lipid profile was found and it could be used as an indicator of metabolic risk in obese children and adolescents.

Keywords: Obesity, Serum uric acid, Children, Lipid profile.

1. Introduction

Obesity in children and adolescents has become a serious public health issue facing the world today. Apart from genetic factors, changes of lifestyle like consumption of excess calorie rich food, lack of physical activity and increased screen time are major contributing factors for childhood obesity [1]. Obesity is characterized by an excess of body fat or adiposity which is most commonly defined by body mass index, a mathematical formula of weight-for-height index which is measured by dividing the body weight into kilograms to height in meters squared [2]. Body mass index and waist circumference are simple and effective anthropometric parameters for classifying obesity and abdominal obesity [3]. Obesity-related comorbidities include cardiovascular disease, hypertension, dyslipidemia, type 2 diabetes, and insulin resistance. This cluster of diseases and disorders is collectively termed metabolic syndrome [4]. Additionally, obesity is associated with sleep apnea, asthma, fatty liver disease, orthopedic problems, polycystic ovary syndrome and psychological problems [5]. Serum uric acid is a product of the metabolic breakdown of purine nucleotides and is endogenously formed by the liver and mainly excreted by the kidneys. Many enzymes are involved in the conversion of the two purine nucleic acids, adenine and guanine, to uric acid [6]. Higher serum uric acid levels can not only lead to gout but also is an essential risk factor of obesity, which may result in increased incidence of metabolic syndrome. That serum uric acid is independently and positively correlated with the risk of obesity [7]. Hyperuricemia is significantly associated with the development and severity of metabolic syndrome, that higher serum uric acid levels lead to an increased risk of metabolic syndrome [8]. The aim of this work was to evaluate serum uric acid levels in association with lipid profile as an indicator of metabolic risk in obese children and adolescents.

2. Patients and Methods

2.1 Participants

An observational, cross –sectional study was conducted on one hundred obese children who were chosen randomly from pediatric outpatient clinic at Al-Azhaar University Hospital during the period from August 2021 to May 2022. The study included one hundred obese children who had BMI ≥ 95th percentile according to the Centers for Disease Control and Prevention (CDC) [9] standards.

2.2 Ethical Considerations

Approval of the study protocol was taken from AL-Azhar University's Local Ethics Committee, Faculty of Medicine for Girls, Cairo. Each child's parents signed a written informed consent form, and Privacy of all data was assured.

2.3 Inclusion Criteria

- Age 8-18 years.
- Male and female.
- BMI ≥ 95th percentile for age and sex fulfilling criteria for obesity in children [9].

2.4 Exclusion Criteria

- Children with chronic diseases.
- Children with congenital anomalies.
- Children with genetic diseases.

2.5 Methodology

During a hospital visit, all patients in this study were subjected to the following: assessed for family medical history, dietary history, medication usage, and demographic information. Using a validated questionnaire to collect data on lifestyle indicators. The questionnaire had 13-items divided into 3 domains that were used to assess lifestyle of children. Physical activity: assessment asked about duration and frequency of any physical activity during the week. Sedentary behavior: included information on time spent during the day in front of a screen watching TV, playing video games and using a computer. Dietary habits: were determined through a set of 10 specific questions, asked to report on the frequency of intake of breakfast, sugar-sweetened drinks (including soda), cooked and uncooked vegetables, fruits, milk and dairy products, doughnuts/cakes, candy and chocolate, energy drinks, in a typical week [10].

2.6 Examinations

Physical examinations, including height and weight measures, as well as BMI (body mass index), waist circumference, blood pressure measure are also required.

2.7 Anthropometric measurement

Weight measurement: after emptying the urine and gastrointestinal systems, the body weight was measured on a scale to the nearest 0.1 kg, barefoot and in light clothing (Seca Model770, Hamburg, Germany). Height: was measured to the nearest 1 cm using a non-elastic tape meter while subjects were in a barefoot standing position, with their shoulders in a normal position. BMI was calculated as weight in kilograms divided by the square of height in meters (kg/m^2). Waist circumference measurement using a plastic tape wrapped around the body in a horizontal position, the waist circumference was measured midway between the lower rib edge and the iliac crest [11].

2.8 Blood pressure measurements

A mercury sphygmomanometer with an adequate cuff size was used for measuring systolic and diastolic blood pressure readings, with the patient sat in the proper position. Three measurements were taken from all the participants at 2 min intervals, and the average of the last two measurements was recorded. According to American Academy of pediatrics for SBP and DBP in the pediatric population values > 95th percentile is considered elevated [12].

2.9 Investigations

Blood sample was obtained after 10 hours fasting for; total cholesterol, triglycerides, high density lipoprotein (HDL), low density lipoprotein (LDL), uric acid, and complete blood count. Five ml of venous blood was withdrawn and divided into two aliquots; 2 ml were evacuated in EDTA tube were used for measurement of CBC. The remaining part (3ml) was evacuated in serum-separator tube, centrifuged at 3000rpm for 10 min; was used for measurement of total cholesterol, triglycerides, high density lipoprotein (HDL), low density lipoprotein (LDL) and uric acid. Measurement of lipid profile and uric acid were done using Cobas C311 (Germany) and kits of Roche (Germany). The following measures were considered lipid profile abnormalities total cholesterol ≥ 170 mg/dL, triglycerides ≥ 130 mg/dL, LDL-C ≥130 mg/dL, HDL-C ≤ 45 mg/dL 13. Serum uric acid was determined enzymatic colorimetric (uricase), measure uric acid abnormalities ≥7mg/dl 14.

2.10 Statistical analysis

Data was analyzed using the Statistical Package of Social Science (SPSS) program for Windows (Standard version 21). According to the type of data, qualitative data were represented as number and percentage, quantitative data were represented by mean ± SD (standard Deviations). The standard deviation score for weight and height was calculated (Z-score). Association between qualitative variables by Chi-square test while Fischer exact test was used when expected cell count less than 5. An unpaired student t-test was used to compare the two groups having quantitative variables. Correlation by Spearman's was used to correlate qualitative variables. P value was set at ≤ 0.05 for significant results & < 0.001 for high significant results. The correlation coefficient denoted symbolically defines the strength and direction of the linear relationship between two variables.

3 .Results

As show in Table .1 that there was no significant difference regarding sex among studied children, while there was a significant increase in the family history of obesity (61%) and type 2 diabetes mellitus (65%), and that there was significant increase in BMI Z score, waist circumference and waist/height ration in obese children, with 84% of them have waist circumference above 90th centile. Also, shows that there was significant increase in blood pressure in obese children; 57% and 38% of them had blood pressure above 95th centile for systole and diastole respectively. As shown in table 2 there was significant increase in sedentary lifestyle in obese children. As shown in Table 3, there was significant decrease in hemoglobin, MCV and MCH in obese children, 15% of children have hemoglobin level below the normal 8 to 12 years and 17% have hemoglobin level below the normal to 18 years. As shown in table 4 there was significant increase in lipoproteins levels abnormality, 47% of children had high cholesterol levels, 96% and 36% had high triglycerides, and LDL levels respectively, while 35% of them had low HDL levels. Also, shows that there was significant increase in serum uric acid levels in obese children; 23% of them had high uric acid levels .As show in table 5 shows that there was significant positive correlation between serum uric acid and the total cholesterol, LDL while negative correlation with HDL.As shown in table 6 the multivariate liner regression analysis of different parameters in the studied children and uric acid. BMI (p= 0.04), and LDL (p=0.029) were positively correlated with serum uric acid.

Table 1: Demographic data and anthropometric measurements and blood pressure among the studied children.

				(n= 100)
Age/ year		Mean ± SD		11.70±2.81
		Range		8.0-18.0
Sex	Male	No / %		50(50.0%)
	Female	No / %		50(50.0%)
Family history of obesity	Positive	No / %		61(61.0%)
	Negative	No / %		39(39.0%)
Family history of Diabetes	Positive	No / %		65(65.0%)
	Negative	No / %		35(35.0%)
BW in kg		Mean ± SD		68.47± 20.72
		Range		32.0-145.0
Height in cm		Mean ± SD		146.67± 14.67
		Range		113.0- 167.0
BMI in kg/m2		Mean ± SD		31.06± 5.09
		Range		21.90- 52.0
Z score (BMI)		Mean ± SD		2.16± 0.13
		Range		0.23-4.11
Waist circumference in Cm		Mean ± SD		90.0± 10.21
		Range		65.0-125.0
Waist to height ratio		Mean ± SD		0.61± 0,06
		Range		0.49-0.78
Waist circumference on centile		$<90^{th}$	No / %	16(16.0%)
		$>90^{th}$	No / %	84(84.0%)
SBP/mmHg		Mean ± SD		122.23±6.41
		Range		110- 140.0
DBP/mmHg		Mean ± SD		78.91±4.12
		Range		65.0-90.0
SBP according to 95th centile		$<95^{th}$	No / %	43 (43.0%)
		$>95^{th}$	No / %	57(57.0%)
DBP according to 95th centile		$<95^{th}$	No / %	62(62.0%)
		$>95^{th}$	No / %	38(38.0%)

Table 2: Distribution of studied children regarding physical activity, sedentary behavior and dietary habits.

		(n= 100) No. / %
Physical activity	Active	45(45.0%)
	Inactive	55(55.0%)
Total screen time (TV viewing and computer use)	Less than 2 h/day	32(32.0%)
	2 h or more/day	68(68.0%)
Sleeping pattern	Less than 8 h/day	62(62.0%)
	8 h or more/day	38(38.0%)
Dietary habits:		
Consumption of vegetables	Daily	42(42.0%)
	Less than daily	56(56.0%)
Breakfast intake	Less than daily	22(22.0%)
	Daily	78(78.0%)
Consumption of fruits	Daily	31(31.0%)
	Less than daily	69(69.0%)
Consumption of milk and dairy products	Daily	38(38.0%)
	Less than daily	62(62.0%)
Intake of sugar-sweetened beverages	Fewer than 4 days/week	52(52.0%
	4 days or more/week	48(48.0%
Fast food intake	Fewer than 4days/week	33(33.0%)
	4 days or more/week	67(67.0%)
Intake of fries/crisps	Fewer than 4 days/week	47(47.0%)
	4 days or more/week	63(63.0%)
Cake/doughnut intake	Fewer than 4 days/week	34(34.0%)
	4 days or more/week	66(66.0%)
Candy/chocolate intake	Fewer than 4 days/week	45(45.0%)
	4 days or more/week	55(55.0%)
Energy drink intake	Fewer than 4 days/week	54(54.0%)
	4 days or more/week	46(46.0%)

Table 3: Distribution of complete blood count in the children studied.

		Studied children(n=100)
Hemoglobin gm/dl	Mean ± SD	11.97±1.39
	Median	12.30
Hematocrit %	Mean ± SD	36.39±2.47
	Median	36.50
MCV fl	Mean ± SD	77.70 ±6.84
	Median	79.10
MCH pg	Mean ± SD	26.21±2.61
	Median	26.25
Platelets (× 109/L)	Mean ± SD	270.10±53.35
	Median	258.50
TLC (× 109/L)	Mean ± SD	8.62±1.68
	Median	8.40
Distribution of hemoglobin according to age		
8 to12y<11.5g/dl	No / %	15(15.0%)
12 to 18y<12g/dl	No / %	17(17.0%)

Table 4: Distribution of abnormal lipoproteins levels and abnormal uric acid in the studied children

Variable		Studied children (n=100)
Uric acid mg/dl	Mean ± SD	5.54±1.01
	Median	5.55
Normal (3-7mg/dl)	No / %	77(77.0%)
High (>7mg/dl)	No / %	23(23.0%)
Total cholesterol mg/dl	Mean ± SD	160.81±36.22
	Median	162.00
Normal (<170 mg/dl)	No / %	53(53.0%)
High (≥200 mg/dl)	No / %	47(47.0%)
Triglycerides mg/dl	Mean ± SD	139.58±34.20
	Median	134.50
Normal (35- 135 mg/dl)	No / %	4(4.0%)
High(≥135mg/dl)	No / %	96(96.0%)
HDL mg/dl	Mean ± SD	42.87±7.10
	Median	42.50
Normal (45-65mg/dl)	No / %	23(23.0%)
High (≥65mg/dl)	No / %	42(42.0%)
Low (<40mg/dl)	No / %	35(35.0%)
LDL mg/dl	Mean ± SD	89.00±32.12
	Median	91.80
Normal (<130mg/dl)	No / %	64(64.0%)
High (≥130mg/dl)	No / %	36(36.0%)

Table 5: Correlation between serum uric acid levels with different parameters in the studied children.

	Serum uric acid mg/dl	
	R	P- value
Age/years	-0.030	0.763
Weight/kg	-0.009	0.930
Height/cm	-0.038	0.705
BMI kg/m2	0.089	0.380
Waist circumference/cm	0.012	0.907
wc to ht ratio	0.143	0.156
H R/beats/min	-0.072	0.479
R R/ beats/min	0.014	0.890
SBP/ mmHg	-0.032	0.749
DBP/mmHg	-0.018	0.861
Hb/gm/dl	-0.151	0.134
Hct (%)	0.082	0.418
Platelets (× 109/L)	0.145	0.156
TLC (× 109/L)	0.101	0.319
Cholesterol mg/dl	0.218	0.029
Triglycerides mg/dl	0.088	0.386
HDL mg/dl	-0.238	0.017
LDL mg/dl	0.253	0.011

$p \leq 0.05$ is considered statistically significant, $p \leq 0.01$ is considered high statistically significant,

Table 6: Multivariate liner regression analysis of different parameters in the studied children and uric acid

	Unstandardized Coefficients		Standardized Coefficients	T	p- value
	B	Standard error	Beta		
Age/ years	.205	.106	.570	1.922	.058
Weight kg	.072	.050	1.485	1.456	.149
Height cm	-.042	.046	-.607	-.904	.369
BMI kg/m^2	-.267	.128	-1.349	-2.089	.040
Waist circumference cm	-.055	.072	-.561	-.770	.444
Waist to height ratio	12.413	10.236	.684	1.213	.229
Heart rate beats/min	.008	.047	.028	.176	.861
Respiratory rate beats/min	.025	.047	.070	.528	.599
SBP mmHg	-.035	.076	-.222	-.457	.649
DBP mmHg	.069	.079	.282	.869	.388
Hemoglobin g/dl	-.051	.080	-.071	-.642	.523
Hematocrit (%)	.051	.043	.124	1.170	.246
Platelets (× 10^9/L)	.003	.002	.159	1.522	.132
TLC (× 10^9/L)	.022	.064	.037	.349	.728
Cholesterol mg/dl	8.343E-6	.003	.000	.002	.998
Triglycerides mg/dl	.003	.003	.095	.827	.411
HDL mg/dl	-.014	.016	-.099	-.855	.395
LDL mg/dl	.009	.004	.273	2.223	.029

B: Regression coefficient; S.E: Standard error

4. Discussion

A cross-sectional study was conducted on 100 obese children with body weights ≥ 95th centile based on CDC criteria.

The aim of this work was to evaluate serum uric acid levels in association with lipid profile as an indicator of metabolic risk in obese children and adolescents.

As regards the demographic data of the studied children, 100 obese children 50 of them were males (50%) and 50 were females (50%) with mean age 11.70 ± 2.81years old. There was no significant statistical difference between studied children as regards sex distribution. Our result is supported by Zardast et al [15] who showed that there is no significant difference between the two sexes

Family history for obesity, type 2 diabetes mellitus, and dyslipidemia, should be considered risk factors for early onset and a major severity of obesity in children 16.

In our study, 61% of the studied children have family history of obesity and 65% have family history of type 2 diabetes. Our results are supported by Corica et al [17] who showed that family history of obesity and type 2 diabetes mellitus is an important risk factor for precocious obesity onset in childhood and influences the severity of obesity.

Lack of physical activity increased sedentary time, and consuming energy-dense food, play important factors for the higher prevalence of childhood obesity 18.

Our study showed that 55% of children were inactive. Regarding screen time, 68% of children reported a screen time of more than 2 h per day. 42% and 31% of children reported regularly consuming vegetables and fruits, respectively. The rate of daily milk consumption was 38%. Furthermore, 48% and 67% of children regularly consumed sweetened beverages and fast food, respectively. In addition, 63%, 66%, 55% and 46% of children consumed fries, cake, candy and chocolate and energy drinks on at least four days per week, respectively. Our results are in agreement with study done by Badawi et al. [19], Abdel-Fattah et al. [20] who showed that faulty dietary habits, sedentary life, and low level of physical activity were significantly associated with obese children.

The body mass index is the most practical way to evaluate the degree of excess weight and risk for metabolic syndrome; however, BMI is not a direct measure of adiposity and cannot distinguish fat from muscle mass **.[21]**

In our study, the mean weight was 68.47±20.72kg, the mean height was 146.67 ± 14.67 cm, The mean BMI was 31.06± 5.09 kg/m2, Z score BMI 2.16±0.13.

Visceral fat may be evaluated by measurement of the waist-to-height ratio it has been promoted to an effective measure of central adiposity in determining cardiometabolic risk**.[22]**

In our study, the mean WC was (90.0± 10.21 cm), and the mean waist-to-height ratio was (0.61± 0.06), with 84% having waist circumference above 90th percentile. Our results are supported by Soliman et al. [23] who stated that waist-to-height ratio is considered as reliable clinical predictor for cardiovascular risk in obese children and adolescents. Also, Setiono et al. [24], found the same results.

Obesity, especially abdominal obesity, is one of the major risk factors of hypertension [25]. In our study, the mean systolic and diastolic blood pressure were (122.23± 6.41mm/Hg), (78.91± 4.12 mm/Hg) respectively, 57% and 38% of the studied children had blood pressure above 95th centile for systolic and diastolic respectively, similar results were reported in previous studies; Wagdy et al. [26] and Taghizadeh et al. [27] who found that there is a high prevalence of hypertension in obese children.

On evaluation of the complete blood count in the studied obese children, 15% of children have hemoglobin level below the normal in age 5 to 12 years and 17% have hemoglobin level below the normal in age 12 to 15 years. the mean hematocrit was (36.39± 2.47), the mean MCV and MCH was (77.70±6.84) and (26.21±2.61) respectively. In previous study by Khan et al. [28], they found lower levels of hemoglobin, MCV, MCH in obese children. Also, Zhang et al. [29] found that there is an elevated prevalence of anemia in obese children .

Dyslipidemia is a cardiovascular risk factor related to obesity [30]. Our study showed that obese children had significantly high lipid abnormality, 47%, 96% and 36% had high cholesterol, triglycerides and LDL levels respectively, while 35% of them had low HDL. Our results are in agreement with study done by Soltero et al. [31], Maffeis et al. [32] who showed that higher levels of blood cholesterol, LDL-C, triglycerides, and HDL-C in the obese children .

HDL is no longer looked at as a protective factor or a risk factor based on the quantities of HDL-c, but as particles with many biological functions, which are not deductible only by the amount of cholesterol transported. Obesity affects HDL-c levels and impacts HDL functionality, especially when associated with metabolic syndrome **.[33]**

Serum uric acid levels are an essential risk factor of obesity, which may result in increased incidence of metabolic syndrome 7. In our study, the mean serum uric acid was (5.54 ± 1.01 mg/dl), 23% of the children had higher serum uric acid levels. Previous studies done by He et al. [34] reported higher serum uric acid level in obese children and adolescents. In addition, Di Bonito et al. [35] reported high prevalence of higher uric acid levels in obese children and adolescents .

In our study there was significant correlation between uric acid and the studied variables in obese children showed positive correlation with total cholesterol, LDL while it showed negative correlation with HDL. Our results are supported by Abd El Aziz et al. [36] who found significantly positive correlation between body mass index, total cholesterol, low-density lipoproteins and serum uric acid, while significant negative correlation of serum uric acid and high-density lipoprotein. In our study multivariate liner regression analysis of different parameters in the studied children and uric acid, showed that BMI (p= 0.04), and LDL (p=0.029) were positively correlated with serum uric acid.

Obesity contributes to disturbances in the metabolism of fats hepatic synthesis of lipid and lipoprotein. The process of disturbance is related to de novo synthesis of purines that augments the production of uric acid. Increased amount of visceral adipose tissue causes insulin resistance affecting uric acid levels, this in turn reduces the high-density lipoprotein cholesterol particles [37]. Thomazini et al. [38] showed that there was significantly positive correlation between uric acid with BMI, total cholesterol and LDL, and negative correlation with HDL.

5. Conclusion

Serum uric acid levels are significantly increased with obesity, and significant correlation with lipid profile was found and it could be used as an indicator of metabolic risk in obese children and adolescents.

Disclosure

The authors have no conflicts of interest in this work.

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