ISSN: 2755-0133

Journal of Medical & Clinical Nursing

SCIENTIFIC Research and Community

Review Article

Open Access

Metabolic Syndrome in Obese Children and Adolescents

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ABSTRACT

Introduction: Metabolic syndrome is one of the complications of obesity with a significant impact on health. This MS is diagnosed according to the International Diabetes Federation 2007 in children aged 10 to 16 years with waist circumference > 90th percentile according to the curves of McCarthy and two of the following metabolic characteristics: HDL C < 40 mg/dL, TG≥150 mg/dL, blood glucose ≥ 100 mg/dL and blood pressure≥130/85mmHg. Goals: We performed a retrospective and prospective study at the pediatric obesity consultation. The main objective is to assess the metabolic syndrome in a population of obese children and adolescents. The secondary objectives are the evaluation of the various criteria of the metabolic syndrome, and the impact of the degree of obesity, the search for comorbidities and their repercussions, and finally the evaluation of the care.

Results: The survey involved 74 children and adolescents, from January 2011 to December 2021.

The frequency of metabolic syndrome is 35.1%. with an average age around puberty of 12.92 years. There is no significant difference in frequency by sex. This frequency increases with the degree of obesity. Insulin resistance remains the first factor responsible for the genesis of MS, Dyslipidemia affects more than a third of these children. Arterial hypertension is noted in 14% of subjects. For glycemic abnormalities, 16.21% of children have fasting hyperglycemia for complications the non-alcoholic fatty liver disease NAFLD affects approximately 33 %of these children, the obstructive sleep apnea OSA was only confirmed in 4% of these children.

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Received: February 12, 2024; **Accepted:** February 19, 2024; **Published:** March 13, 2024

Introduction

In 1988, Reaven and colleagues described "the metabolic syndrome" as a link between insulin resistance and hypertension, dyslipidemia, type 2 diabetes, and other metabolic abnormalities associated with an increased risk of atherosclerotic cardiovascular diseasese, in adults [1]. In 1989, Kaplan renamed this syndrome "the deadly quartet" for the association of upper body obesity, glucose intolerance, hypertriglyceridemia and hypertension It was only in 2001 that the National Cholesterol Education Program (NCEP) proposed the term "metabolic syndrome" and which is defined by the presence of 3 out of 5 criteria which are central obesity, hyperglycemia, hypertriglyceridemia, decreased high-density lipoprotein (HDL) and high blood pressure (hypertension) [2,3].

In 2007, a new definition was published, that of the International Diabetes Federation IDF [4]. Metabolic syndrome increases with the explosion of the obesity epidemic; we chose to research the frequency of this syndrome in a population of obese children and adolescents.

Methods

Study Population

Study carried out at the service level pediatrics Mustapha University Hospital. We selected between January 1, 2011 and 31 December 2021, 74 children and adolescents.

The Inclusion Criteria are

-Age ≥10 years.
-Body mass index greater than 2 ZScore according to WHO 2007 curves.

The Non-Inclusion Criteria are

-Age <10 years old.
-Associated chronic illness,
-Syndromic or genetic obesity.

Data on age, gender, cardiovascular disease, type 2 diabetes, obesity and hypertension. Height and weight were measured by the same pediatrician. BMI was calculated as weight in kilograms divided by height in meters squared. Obesity was defined as a BMI≥2 ZSC. Percentile and SDS assessments of weight, height and BMI were made according to the standards of the WHO.

Waist circumference (WC) was measured at the level of the umbilicus with the patient standing and breathing normally. We assessed metabolic and cardiovascular risk in the 74 children and adolescents, using the waist-to-height ratio. This risk is high if this ratio ≥0.5. Blood pressure was measured with the auscultatory method using appropriate cuff, in the fasting state and after 20 minutes of rest.

Biochemical Definitions and Insulin Sensitivity

Plasma glucose, insulin and lipid levels were measured in blood samples obtained in the morning by venipuncture after an overnight fast. Homeostasis model assessment-insulin resistance (HOMA-

IR) was calculated according to the formula proposed by Levy et al (5): HOMA-IR=Fasting blood glucose [mmol /L] x Fasting insulin [iu /ml] /22.5 <2.5.

Plasma concentrations of total cholesterol, high-density lipoprotein-cholesterol (HDL-cholesterol), triglycerides and blood glucose were measured using routine enzymatic methods [5].

Abdominal Ultrasound: looking for hepatic steatosis. And pelvic looking for polycystic ovarian syndrome in girls.

Polysomnography: if sleep apnea syndrome is suspected.

Diagnostic Criteria for Metabolic Syndrome

The International Diabetes Federation considers that an individual between 10 and 16 years old has metabolic syndrome if they have a waist circumference > 90th percentile according to the MacCarthy curves [appendix 6] in addition to at least 2 other criteria of the 4 following:

- Hypertriglyceridemia ≥ 150 ml /dl [1.7 mmol/l].
-HypoHDL Cholesterolemia < 40 mg/dL [< 1.03 mmol/L].
-Systolic blood pressure ≥ 130mm Hg or diastolic ≥ 85 mm Hg.
-Hyperglycemia ≥ 5.6 mmol /l (100 mg /dl or known type 2 diabetes).

Statistical Analysis Plan

p<0.05 Statistical analyzes were performed by SPSS (Statistical Package for Social Sciences) Chi2 test for comparing two or more percentages. ANOVA test for comparing multiple means. Identification of potential risk factors by estimating the odds ratio and its 95% confidence interval (CI).

Results

The mean age of the group was 12.26±1.9 years (range: 10-16 years) and the mean body mass index standard deviation score (BMI-SDS) was 2.57±0.59. The subjects with a West C>90th percentile constituted 100% of the cases. The clinical and metabolic characteristics of the male and female patients are listed in Table 1.

According to the International Diabetes Federation 2007 criteria, 26 of the 74 patients (35.1%) were diagnosed with MS. And after reevaluation with the Ferrani and all criteria, MS was detected in 29 of them (39.2%) and (29.7%) had MS according to Ford.al and Cook.al. And 31.8% of the work force has a single definition criterion in addition to abdominal obesity. (IDF)

BMI values in the obese females were higher than those in the males and, females were predominant among MS patients. Age, BMI of the patients with MS were significantly higher than those of the non-MS patients (p=0.026 / p=0.049). In 16 patients (22%) who were defined as severely obese, BMI (ZScore) was above 4, MS was detected in 50% (n=8/16) versus 31% (n=18/58) of non-severe obese patients, respectively (p<0.05) (Figure 1). When the patients were divided into age groups as <12 years and ≥12 years, the MS was found to be significantly higher in the second group (p=0.010).

There Frequency of Metabolic Abnormalities East

100% for abdominal obesity defined by a waist circumference ≥ P90, and 100%of them have a cardiovascular and metabolic risk with a WC/Height ratio > 0.5. 33.78% have hypoHDL cholesterolemia 28% have hypertriglyceridemia **13.51%** have systolic hypertension and 5.4% for diastolic hypertension, **16.21%** have fasting hyperglycemia (defined by the ADA 2003) **75%** have a higher Homa-IR has 2.5[done only in 28 children] Figure 2.

In Table 2, MS and non-MS obese patients are compared according to their metabolic characteristics, anthropometric measurements and risk factors for MS. The proportion of patients who had high triglyceride and HDL cholesterol levels were 28% and 33.78% in the MS group. There was a statistically significant difference between the two groups for triglyceride levels (p=0.00), and for HDL cholesterol (p=0.00).

Impaired fasting plasma glucose was detected in 12 patients 16.21%. (p>0.05). All children with MS in whom HOMA-IR was performed have confirmed insulin resistance [HOMA IR > 2.5]. HOMA IR is significantly higher in children with MS (p=0.036).

Table 1: Comparison of Clinical and Biological Characteristics According to Sex

	F	M	P
Age (years)	12.45±2.06	12.00±1.68	0.316
Weight (kg)	75.64±21.95	74.32±19.08	0.073
T (cm)	147.28±12.47	153.96±12.14	0.185
BMI(Kg/m^2)	32.65±6.15	30.49±4.26	0.094
WC (cm)	Phone: 99.61±15.17	100.00±12.78	0.908
WC/H	0.65±0.08	0.63±0.06	0.392
SYS (mm hg)	112.67±12.97	116.74±14.64	0.239
DYA (mm hg)	65.77±10.29	71.48±12.84	**0.050**
HDLC (mg/dl)	0.44±0.13	0.48±0.21	0.392
TG (mg/dl)	1.22±0.55	1.22±0.53	0.448
HOMA-IR	5.23±2.69	2.52±1.61	**0.006**
GLY (g/l)	0.89±0.11	0.93±0.09	0.156

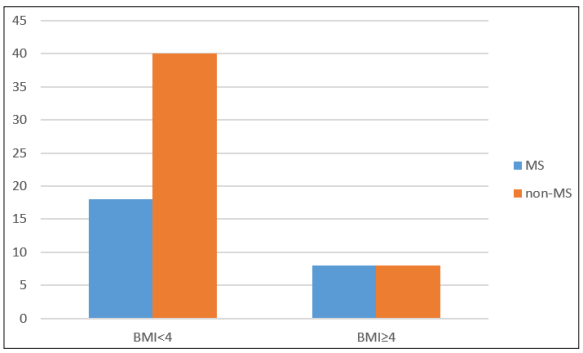

Figure 1: MS was 31% and 50% in Obese Patients who have BMI-SDS<4 and BMI-SDS≥4, Respectively (p<0.05)

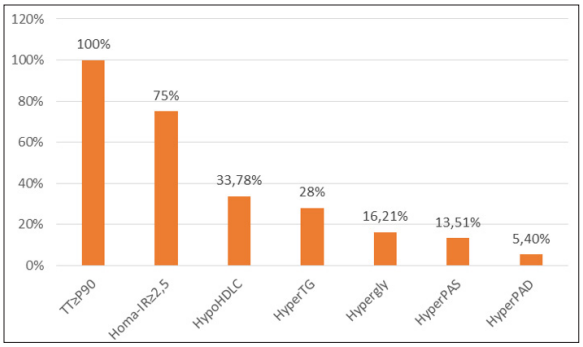

Figure 2: Frequency of Metabolic Abnormalities

Table 2: Comparison of the Means of Clinical and Biological Criteria Between Children [MS] and Children Non-MS

	MS (+)	Non-MS	
Age [years]	(10-16) 12.92	(10-16) 11.90	0.026
BMI(Kg/m^2)	(27.00-54.70) 33.41	(23.00-46.00) 30.79	0.049
WC(cm)	(79.0-149.0) 103.32	(70.0-132.0) 97.72	0.109
WC/H	(0.52-0.91) 0.66	(0.51-0.83) 0.63	0.222
SYS(mmhg)	(90-150) 119.74	(80-140) 111.44	0.018
DYA(mmhg)	(50-90) 70.43	(40-90) 66.86	0.238
HDLC (mg/L)	(0.25-0.54) 0.35	(0.12-0.90) 0.52	0.000
TG(mg/L)	(0.71-2.87) 1.64	(0.38-1.88) 0.90	0.000
HOMA-IR	(2.51-11.00) 5.55	(0.44-7.40) 3.41	0.036
Blood sugar	(0.63-1.20) 0.93	(0.68-1.08) 0.90	0.214

Abdominal ultrasound was performed in 42 children and NAFLD was found in 14 children [33%] including 5 with MS. Out of 14 children with NAFLD, 8 benefited from the HOMA-IR calculation and it is > 2.5. Among them, 42% have dyslipidemia. Which confirms that NAFLD is closely linked to insulin resistance and dyslipidemia but not correlated with BMI Zscore (p =0.292) Only 2 children presented with hepatic cytolysis related to NAFLD.

Discussion

Metabolic syndrome is one of the complications of obesity with a significant impact on health. This MS is diagnosed according to the FID in children aged 10 to 16 years with waist circumference > 90th percentile according to the curves of MacCarthy and at least two of the following metabolic characteristics: HDL < 40 mg/dL, TG≥150 mg/dL, blood sugar≥ 100 mg/dL and blood pressure≥130/85 mmHg [4]. This study carried out between the 1st January 2011 and December 31, 2021involved 74 children and adolescents and made it possible to evaluate the frequency of metabolic syndrome in a population of obese children and adolescents.

In our study, 35.1% of obese children aged between 10 and 16 years developed metabolic syndrome. These results are similar to other publications [6]. Among them,42.85% are girls and 25% boys with no significant difference between the two sexes (p=0.111) this is correlated to the most studies which have not found an impact of sex on the prevalence of metabolic syndrome.

The average age is 12.92 years old±1.8 approaching puberty. There is a significant difference between the group of children in puberty ≥12 years old and children in prepuberty<12 years (p=0.010). Several arguments suggest that puberty is a favorable period for the onset of MS.

The risk of MS increases with each year gained (p=0.026) [Odds-ratio =2.308] [IC=1,035-5,151]. Children with MS are heavier (p=0.023) [Odds-ratio =1.029] [IC=1,003-1,005]. and have a higher BMI with a significant difference [p=0.049], which supports the hypothesis that the degree of obesity influences the genesis of MS.

All the children have an obese android with a round of size > P90 and a WC/H ratio > 0.5. This ratio is a good predictor of metabolic and cardiovascular complications as suggested by various studies. Insulin resistance is the essential component of the MS and this has been demonstrated [7-9].

Acanthosis nigricans, a powerful clinical marker of this insulin resistance, also appears to be a powerful predictor of metabolic syndrome [10]. In fact, in our study, AN was strongly associated with a higher risk of metabolic syndrome; it was found in half of MS+ children. The HOMA-IR is > 2.5 in 40% of children AN+.

All children with MS who benefited from the HOMA-IR calculation had an index > 2.5 compared to 56% for the rest of the children (p = 0.036); which is correlated to all the literature data which stipulate that insulin resistance is the first mechanism responsible for the genesis of MS [1].

High blood pressure was found chez 14% of the workforce, this is essentially systolic hypertension.13.51% versus 5.4% for diastolic, these figures are close to literature data which is 10%. Concerning the lipid profile,hypoHDL cholesterolemia is found in 33.78% of cases and 28% for hypertriglyceridemia, with a very significant difference between children with and without MS (p=0.000). The same difference was found in a Tunisian study which compared the prevalence of SM using four definitions. The result is similar using all 4 definitions [10].

For glycemic abnormalities, 16.21% of children have fasting hyperglycemia but diabetes does not summer retained in none of the patients unlike to the various studies which report even a low frequency of diabetes [10]. NAFLD is found in 14 children (33%) 5 boys and 9 girls, The prevalence rate of NAFLD worldwide ranges from 10% at 70% [11,12]. The obstructive sleep apnea OSA was only confirmed in 4% of these children. For care, 92% only benefited from dietary support, only 2 children received medical treatment for high blood pressure.

Conclusion

In conclusion, in parallel to the obesity epidemic, the prevalence of the MS in children and adolescents shows an alarming increase, becoming a growing problem in childhood. Severe obesity, age, pubertal status, cardiovascular disease, type 2 diabetes, obesity or hypertension appear to be important risk factors associated with MS in childhood. Further studies are needed to revise the diagnostic criteria in childhood and to reach a consensus on the diagnosis of MS.

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