

Metabolic Syndrome in Children with Overweight and Obesity

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ABSTRACT

Background: While many studies have been conducted on the prevalence and complications of metabolic syndrome in adults, few pediatric studies are available, particularly in developing countries. The aim of this study is to determine the prevalence of metabolic syndrome and its components among children and adolescents with overweight and obesity in Sfax, Tunisia. as well as to look for predictive factors for the occurrence of this pathology. **Methods:** This cross-sectional study involved 84 children and adolescents with overweight and obesity admitted to the endocrinology department of Hédi Chaker Hospital, Sfax from 2015 to 2019. For each participant included in the study, a clinical examination was conducted to determine height (cm), weight (kg), waist circumference (cm), and BMI as weight/height² (kg/m²). A fasting blood sample was taken to assay the different biological parameters. **Results:** Between 44 boys and 40 girls, the average age was 11.83 years. Family history of obesity was noted in 84.5% of cases. The average weight was 72.68 kg, with an average BMI of 31.55 kg/m². Obesity was reported in 78.6% of patients and overweight without obesity in 21.4%. According to adapted NCEP/ATP III criteria, 16.7% of patients had metabolic syndrome. Metabolic syndrome was observed in 15.9% of boys and 17.5% of girls, with no significant difference. In our study, no predictive factors were found. **Conclusion:** The prevalence of metabolic syndrome was high in our study. We suggest targeted screening programs for at-risk children and adolescents to control obesity and metabolic syndrome in Tunisia.

Keywords: Metabolic syndrome; prevalence; obesity; overweight; child; adolescent

INTRODUCTION

Metabolic syndrome (MetS), described in 1988 by Reaven (1), is the presence of a number of cardiovascular risk factors in the same individual: specifically, abdominal obesity, glucose intolerance, hypertension, hypertriglyceridemia, and hypo-HDL cholesterolemia (2). While metabolic pathology has been thoroughly examined in adults, it is less studied in the pediatric population, despite the potential for complications into adulthood (3,4). Related to the

increasing incidence of obesity, the prevalence of MetS is increasing globally (5). This prevalence varies by country, particularly according to the definition criteria used. In Tunisia, there is little data on MetS in children with obesity. In a recent study carried out by Jmal et al. (6), MetS was found in 14.3% of children with obesity and 1% of children with overweight.

Several criteria defining MetS have been proposed by scientific societies, including WHO, IDF, NCEP/ATP III, EGIR, and AACE (2,3,7,8,9,10). In the pediatric population, the most used criteria for defining MetS are those proposed by IDF and NCEP/ATP III, adapted for age and sex.

The exigence of this topic lies in the increasing frequency of metabolic disorders, which are associated with poor lifestyle choices and can lead to both medium- and long-term complications for patients. The primary objective of this study is to determine the prevalence of MetS and its parameters in children and adolescents with overweight and obesity in Sfax Tunisia as well as identify predictive factors for MetS occurrence.

MATERIALS AND METHODS

We carried out a descriptive and analytical cross-sectional study of childhood obesity by examining the records of children and adolescents admitted to the endocrinology department of Hédi Chaker Hospital in Sfax, Tunisia between January 2015 and December 2019. Overweight and obesity were defined using age- and sex-specific BMI thresholds proposed by the International Obesity Task Force, which correspond to the most widely used adult thresholds of 25 and 30 kg/m², respectively (11).

Children and adolescents with Overweight (BMI > IOTF-25, which is equivalent to BMI ≥ 97th percentile) with or without obesity were included.

Anthropometric Measurements

For each participant included in the study, a clinical examination was conducted to determine height (cm), weight (kg), waist circumference (cm), and BMI as weight/height² (kg/m²). Waist circumference was measured at the mid-point between the lowest rib and iliac crest along the mid-axillary line at the end of expiration. Blood pressure was measured using a mercury sphygmomanometer.

Biological Parameters

A fasting blood sample was taken from each patient to obtain plasma, glucose, total cholesterol, triglyceride, and HDL-C.

Definition of MetS

To identify MetS, we used NCEP/ATP III criteria adapted for children (12). These criteria correspond to the presence of at least three of the following five abnormalities: android obesity indicated by waist circumference > 90th percentile, glucose intolerance indicated by fasting plasma glucose ≥ 5.5 mmol, high blood pressure > 90th percentile, hypertriglyceridemia greater than 1.1 mmol/L, and hypo-HDL cholesterolemia < 0.4 mmol/L.

Due to the lack of suitable reference curves regarding the waist circumference of Tunisian children, we used the curves waist circumference developed from the National Health and Nutrition Examination Survey III (NHANES III) (13).

STATISTICAL STUDY

Statistical analysis was performed using SPSS 20. Continuous variables were presented as an average $\pm$ two extremes. Qualitative variables were presented as frequency percentages. Percentage comparisons were conducted using a chi-squared test, and continuous variable, comparisons were conducted using a student's *t*-test.

RESULTS

Sociodemographic and Clinical Characteristics

In total, 84 children were included in the study, with 44 boys and 40 girls. The average age was 11.83 years (2-17). Seventy-one percent of participants lived in urban areas and 29% in rural areas. Sixty percent attended primary school, 36.6% attended secondary school, and 3.4% were unschooled.

Family history of obesity was noted in 84.5% of cases. Seventy-seven percent had a family history of cardiovascular disease. Only one patient (1.2%) was under long-term corticotherapy, and four patients (4.7%) were taking neuroleptics. Average birth weight was 3.2 kg (1.7 kg - 4.95 kg); 10% of participants had a birth weight less than 2,500 g, 77% between 2,500 and 4,000 g, and 10% more than 4,000 g (Fig 1).

The average weight was 72.68 kg (20 kg -125 kg) with an average BMI of 31.55 kg/m².

Obesity was reported in 78.6% of patients and overweight without obesity in 21.4% of cases. (Fig 2). It was primary in 96.4% of cases.

The average waist circumference was 98.7 cm (65 cm-145 cm). Abdominal obesity was reported in 97% of cases.

. The impact of obesity was metabolic 17.9% (prediabetes and dyslipidemia), cardiovascular 3.6% (high blood pressure), mechanical 4.8%, and respiratory 7.1%.

Biological parameters

The mean fasting plasma glucose level was 4.8 mmol/l (3.4 mmol/l-6.6 mmol/l), the mean total cholesterol was 4 mmol/l (2.25 mmol/l-6 mmol/l), the mean triglyceride was 1.01 mmol/l (0.4 mmol/l-2.7mmol/l), and mean high-density lipoprotein cholesterol (HDLc) was 1.12 mmol/l (0.35 mmol/l -2.04 mmol/l). The clinical and biological characteristics are presented in Table 1.

Characteristics of MetS

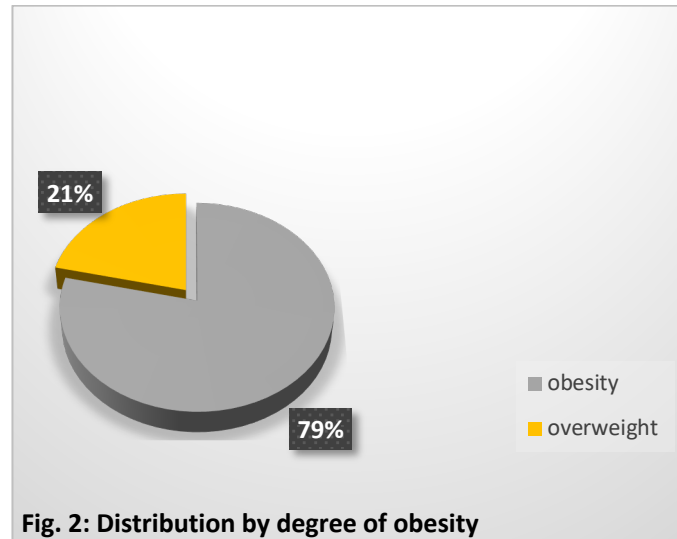
Prevalence

According to the criteria of NCEP ATP III adapted, 16.7% of patients had MetS: 17.3% in children with obesity and 13.2% in children with overweight without obesity. This MetS was observed in 15.9% of boys and 17.5% of girls, 4.8% of children under 10, and 23.2% of those over 10.

Eighty percent of patients with a family history of obesity had MetS. No cases were recorded in patients without a family history of obesity. It occurred in 18.5% of patients with a family history of cardiovascular disease and in 10.5% of patients without a family history of cardiovascular disease. According to physical activity, 18.5% of patients with low physical

activity had MetS versus 11% of patients who had moderate physical activity (Table 2). In our study, no predictive factors were found.

Among all the components of MetS, android obesity was the most prevalent at 82%, followed by hypertriglyceridemia, hypo HDL cholesterol, mild fasting hyperglycemia, and high blood pressure at 22.6%, 20.2%, 12%, and 4.8%, respectively.



Nine-point five percent had no criteria, 3.6% of children had 4 defining criteria, and none had all five criteria at the same time. The distribution of subjects by MetS criteria is presented in Table 3.

Table 3. Distribution according to the number of criteria for MetS

	0	1	2	3	4	5	
Number	8	44	18	11	3	0	84
Percentage	9.5%%	52.4%	21.4%	13.1%	3.6%	0%	100%

DISCUSSION

Childhood obesity is a major risk factor for metabolic complications, such as insulin resistance and MetS, which lead to cardiovascular comorbidities in adulthood (14). The prevalence of MetS in children varies according to the nature of the population studied and to the criteria used (15). In our study, we used modified NCEPIII criteria, and we found an overall prevalence of MetS of 16.7%. The results of this study are generally consistent with the literature, including previous Tunisian studies.

A meta-analysis published in 2020 focused on MetS among children and adolescents in low- and middle-income countries. It estimated that the pooled prevalence of MetS was 24.1%, based on three diagnostic methods: IDF, ATP III, and de Ferranti. According to the modified ATP III, the pooled prevalence of MetS was 36.51% (16). These two values were higher than those found in our study. In Tunisia, some studies have been carried out to estimate the prevalence of MetS in children. The results of those studies are variable.

The results closest to ours were from Jmal et al., who found a prevalence of MetS of 14.3% (6). It should be noted that those researchers used IFD.

Two other Tunisian studies used the IDF criteria, and the prevalence of MetS they found was higher than in our study. The result from Jamoussi et al. from Tunis was 34.4% while Regaieg et al. found 21.6% in Sfax (17,18). In a study in Iran that used the IDF definition, Ahmadi et al. found a prevalence of MetS of 7.6% (19), which was lower than our results. A lower prevalence (3.7%) was reported by Mahajan in India (20), and an even lower rate (1.1%) was reported by Wang in China (21).

Table 4 shows the prevalence of MetS in our study compared to the results of different studies. In the present study, there was no significant difference based on gender. The prevalence of MetS was 15.9% in boys and 17.5% in girls. Similar results were found by the Tunisian authors Regaieg, Jmal and Jamoussi (17,18). By contrast, Wang reported a significantly higher prevalence of MetS in boys than in girls (21).

In our study, the prevalence of MetS was 17.3% in children with obesity and 13.2% in children with overweight without obesity. The difference between the two categories was not statistically significant. This was different from most of the scientific literature (6,18–20,22,23,23,24).

Applying the modified ATP III NCEP criteria, Abdennebi et al. studied a series of 607 children between 6 and 12 years old. There were 75 children with obesity, 184 with overweight, and 348 normal-weight controls (25). This represented frequencies of 25.3%, 7.6%, and 0.3%, respectively.

Jemal et al. found that the prevalence of MetS was significantly higher in children with obesity (14.3%) than in children with overweight (1%) and controls (0%) (6).

In the Regaieg series, 25% of subjects with obesity and 15.8% of subjects with overweight met the criteria for MetS the difference between the two groups was statistically significant (18).

The absence of a significant difference between children with overweight and those with obesity in the present study can be explained by the nature of the sample, which consisted mainly of children with obesity; those who were overweight were a considerable minority.

Among all the components of MetS, android obesity was the most prevalent at 82%, followed by hypertriglyceridemia, hypo HDL cholesterol, mild fasting hyperglycemia, and high blood pressure at 22.6%, 20.2%, 12%, and 4.8%, respectively.

Abdennebi found obesity in 83% of cases (25), while Regaieg et al. found 93% (18). In Jamoussi's study, all the children had abdominal obesity, and Jmal found abdominal obesity in 88.6% of cases (6,17).

This high prevalence of android obesity in Tunisian children can be explained by poor eating habits as well as the absence of physical activities, especially among children and adolescents with overweight and obesity.

Our study had several limitations, particularly its retrospective nature with missing data and the fact that it included exclusively patients with overweight and obesity. However, it is a descriptive study with an analytical objective and a considerable sample size, allowing an estimate of the prevalence of MetS and its components in a pediatric population.

CONCLUSION

In our study, the prevalence of MetS was high at 16.7%, and there was no significant difference between children and adolescents with obesity and those with overweight. Certain components, particularly abdominal obesity and hyperTG, were far more prevalent. More than 38% of children had at least two components. Because of the high prevalence of MetS in Tunisian children, especially those with overweight and obesity, expanded screening for this syndrome is recommended to avoid complications in adulthood.

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Table 1. Clinical and biological characteristics according to sex

Parameter	Girls (n = 40)	Boys (n = 44)	p
Age (years)	12.5 (±3.8)	11.2(±3.09)	.089
birth weight (kg)	3.26 (±0.64)	3.18(±0.68)	.681
Weight (kg)	74.9 (±26.2)	70.7 (±23.7)	.450
BMI (kg/m ²)	30.7 (±5.7)	29.93 (±5.5)	.497
WC (cm)	98.84 (±14.46)	98.54 (±15.55)	.934
DKI (kcal)	2310 (±820)	2662 (±880.5)	.078
FPG mmol/l	4.82 (±0.61)	4.89 (±0.86)	.702
TC (mmol/l)	4.1 (±0.8)	3.8 (±0.62)	.186
TG (mmol/l)	1.16 (±0.59)	1.02 (±0.47)	.278
HDLc (mmol/l)	1.11 (±0.31)	1.12 (±0.35)	.861

Abbreviations: WC: waist circumference, DKI: daily calorie intake, FPG: fasting plasma glucose, TC: total cholesterol, TG: triglycerides, HDLc: high-density lipoprotein cholesterol

Table 2: Prevalence of MetS by characteristics of the population studied

	MetS +	p
Sex		
M	15.9%	.845
F	17.5%	
Degree of obesity		
Overweight	13.2%	.654
Obesity	17.3%	
Age		
< 10 years	4.8%	.072
≥10 years	23.2%	
Family history of CVD		
Yes	18.5%	.414
No	10.5%	
Physical activity		
Low	18.5%	.149
Moderate	11%	
Abbreviations: M: male, F: female, CVD: cardiovascular diseases		

Table4: MetS prevalence by study

Author	Country	Method	Prevalence of MetS
Ours	Tunisie	NCEP III	16.7%.
Bitew	meta-analysis	IDF	24.1%,
		NCEP III	36.51%
Jmal	Tunisie	IDF	14.3%
Jamoussi	Tunisie	IDF	34.4%
Regaieg	Tunisie	IDF	21.6%
Ahmadi	Iran	IDF	7.6%
Mahajan	India	NCEP III	3.7%
Wang	China	IDF	1.1%

