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Original article

Prevalence of metabolic syndrome among obese school students

Nayera E. Hassan [a], Sahar A. El-Masry [a,*], Walaa A. Fouad [b], Lobna Sherif [c], Amany Elwakkad [d], Mona Anwar [d], Safaa T. Zaki [c]

[a] Biological Anthropology Dept., Medical Research Division, National Research Centre, Elbohooth St (El-Tahrir previously), Dokki, Greater Cairo 002, Giza, Egypt
[b] Community Medicine Dept., Medical Research Division, National Research Centre, Dokki, Giza, Egypt
[c] Child Health Dept., Medical Research Division, National Research Centre, Dokki, Giza, Egypt
[d] Medical Biochemistry, Medical Research Division, National Research Centre, Dokki, Giza, Egypt

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SUMMARY

Objective: Assessment of the prevalence of Metabolic Syndrome among Egyptian school students suffering from obesity.
Methods: This study included 462 Egyptian school students who suffer from obesity where their body mass index was >95th percentile. Their age ranged between 7 and 18 years. Clinical, anthropometric and laboratory assessment were done to all cases. The diagnosis of Metabolic Syndrome was done according to modified WHO criteria adapted for children (1999).
Results: Cases who were diagnosed as having Metabolic Syndrome represented 39.7% of the whole percentage of cases. The incidence rate among prepubertal students (45.5%) was higher than among pubertal ones (37%) ($p < 0.001$). The prevalence of metabolic syndrome was higher in girls than boys in the pubertal group, while boys have the higher prevalence in the prepubertal age. Hypertension was significantly higher in pubertal (22.3%) than in the prepubertal group (14.8%) ($p < 0.000$). The prevalence of hyperinsulinaemia in the prepubertal group (13.6%) was significantly higher than in the pubertal group (3.3%) ($p < 0.001$). However, the prevalence of impaired fasting glucose (25.0%) and insulin resistance HOMA-IR (22.8%) in the pubertal group was significantly higher than the prepubertal group (20.5% and 13.6% respectively) ($p < 0.01$). Dyslipidaemia in the prepubertal group was 93.2% and in the pubertal group was 91.3% with a significant differences ($p < 0.000$).
Conclusions: The prevalence of Metabolic Syndrome in the studied sample was higher in prepubertal than pubertal students and in girls more than boys.

1. Introduction

The prevalence of overweight and obesity is increasing rapidly worldwide in all age groups.[1] About 110 million children and adolescents are now classified as being overweight or obese.[2] Obesity is the sixth most important risk factor contributing to the overall burden of disease worldwide.[3] It is associated with a constellation of metabolic derangements during the pediatric age.[4]

In Egypt, a study among female adolescents showed that 35 percent of the girls were overweight and 13 percent were obese. Overweight was more prevalent in urban than in rural girls.[5] In the final report of Diet, Nutrition and Prevention of Chronic non communicable diseases in Egyptian Adolescents (DNPCNCD),[6] it was found that about 20.5% of the adolescents were either overweight or obese with higher prevalence among urban than rural and females compared to males.

Childhood obesity has significant adverse health consequences because it is associated with dyslipidaemia, hypertension, glucose intolerance and it predisposes to early cardiovascular disease.[7] This constellation of metabolic disturbances has been defined as Metabolic Syndrome (MS). The Metabolic Syndrome (MS) has become one of the most severe health problems of the 21st century.[7]

Insulin resistance (IR) has been implicated in the pathogenesis of this syndrome, moreover obesity in children and adolescents is the most common feature associated with IR.[8] Other diagnostic correlations of Metabolic Syndrome other than obesity are: elevated triglyceride concentrations, low high-density lipoprotein cholesterol (HDL-C) concentrations, elevated blood pressure (BP),

* Corresponding author. Tel.: +20 35630921.
E-mail address: masrysa@yahoo.com (S.A. El-Masry).

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and elevated fasting glucose concentrations. These 5 factors appear to be closely allied with increased risk of developing type 2 diabetes mellitus and cardiovascular diseases. When a person is found to have any 3 of the 5 component risk factors, diagnosis of metabolic syndrome must be taken in concern.[9,10]

Pediatric MS has been reported to predict adult MS and type 2 diabetes mellitus.[11] It has been suggested that the burden of Metabolic Syndrome is growing in young populations, especially in developing regions.[12]

Magnussen et al[13] and Ford et al[14] reported that in 27 publications, authors used 40 unique definitions of the Metabolic Syndrome. Most of these definitions were adaptations of the adult definition developed by the National Cholesterol Education Program. In 11 studies that used exploratory factor analysis, the number of components ranged from 5 to 19, and the number of factors identified ranged from 1 to 5. They concluded that the use of multiple definitions of the Metabolic Syndrome argues strongly for the development of a standard pediatric definition.[13,15]

In a study in USA, the prevalence of Metabolic Syndrome was high in obese children and adolescents, and the prevalence was directly proportion to the state of obesity.[16]

The purpose of this research is to assess the prevalence of Metabolic Syndrome and the other metabolic features (i.e. hypertension, impaired fasting glucose, hyperinsulinaemia, insulin resistance and dyslipidaemia) among obese school students.

2. Subjects and methods

This was a cross-sectional survey study compromising 5798 students (2655 boys and 3143 girls). They were recruited from 6 public schools (two primary, two preparatory and two secondary schools) in Giza governorate, in the period from October, 2007 till April 2009. Permission was granted by the Ministry of Education, and the principal of the school .The parents and students' approval was taken as a written consent.

Students complaining of obesity represented only 8% of the total sample. They were four hundred and sixty-two students (174 boys and 288 girls), their mean age was 13.43 + 2.65 years. Students of the prepubertal period represented 26.4% while those of the pubertal period represented 73.6% (Table 1)These students fulfilled the following inclusion criteria : age 7–18 years and BMI greater than the 95th percentile for age and gender based on the Egyptian Growth Reference Charts.[17] Students included in the study did not have any prior major illness, (including type 1 or 2 diabetes). They neither took medications nor did they have any condition known to influence body composition, insulin action or insulin secretion (e.g. glucocorticoid therapy, hypothyroidism and Cushing's disease). Written consent for lab investigations was taken from the parents of 136 students only.

Each student had a complete physical examination, including anthropometric measures. Their pubertal developmental stages were assessed using the criteria of Tanner stages. Height was measured to the nearest 0.5 cm using a Holtain portable anthropometer, and weight was determined to the nearest 0.1 kg using a Seca scale Balance with the subject dressed in minimal clothes and no shoes. The body mass index (BMI) was calculated as weight (in kilograms) divided by height (in meters) squared. The waist circumference was measured at the level of the umbilicus with the subject standing and breathing normally. The hip circumference was measured at the level of the iliac crest, using a non-stretchable plastic tape to the nearest 0.1 cm. Each measurement was taken as the mean of three consecutive measurements, using standardized equipments and following the recommendations of International Biological programs.[18] The blood pressure was measured with a standard mercury sphygmomanometer after the subjects had rested for at least 10 min. The blood pressure measurement was repeated for 3 consecutive days, to ensure the diagnosis of hypertension.

Morning blood glucose, insulin and lipid profile were measured after an overnight fasting. Plasma glucose was determined by the glucose oxidase method. Plasma insulin was measured using ELISA immunoassay (DRG Diagnostic Products Corporation, Los Angeles, CA). Blood concentrations of total cholesterol and triglycerides were estimated in serum using calorimetric assay kit produced by P.Z. cormay, Lublin, Poland. High-density lipoprotein-cholesterol (HDL-C) was determined in serum by using calorimetric assay kits produced by Stanbio laboratory, Boerne, Texas. Low-density lipoprotein-cholesterol (LDL-cholesterol) was calculated as follows:

$$\text{LDL} = \text{total cholesterol} - \text{HDL} = \frac{\text{TG}}{5}$$

* Definitions
* High WC: If WC > 90th percentile for age and sex.
* Hypertension:
  Systolic or diastolic blood pressure > 90th percentile for age and sex
* Abnormal glucose homoeostasis: Any of the following according to modified WHO criteria adapted for children (1999)[19]:
  1. Impaired fasting glucose:
     Following American Diabetes Association recommendations, a fasting glucose of 110 mg/dL (6.1 mmol/L) is defined impaired fasting glucose (IFG).[19]
  2. Hyperinsulinaemia:
     Hyperinsulinaemia was defined from norms for pubertal stage: prepubertal > 15 mU/L; midpubertal (stages 2–4) > 30 mU/L[20]
  3. Insulin resistance:
     Insulin resistance is defined as the levels of the HOMA-IR greater than 3.16, according to Keskin et al.[21] **HOMA-IR** (The homeostatic model assessment for insulin resistance) was calculated as follow:
     HOMA-IR = fasting insulin (μU/mL) *x* fasting glucose (mmol/L)/22.5
* Dyslipidaemia: Any of the following:
  a. High triglycerides [>110 mg/dL]
  b. Low HDL-cholesterol [<40 mg/dL].
  c. High total cholesterol [>210 mg/dL].
* High LDL–Cholesterol [>130 mg/dL]
* Metabolic Syndrome:
  The definition of Metabolic Syndrome; proposed in the Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (NCEP/ATP III)[22]; was modified according to the pediatric age by **Grundy**.[23] Metabolic Syndrome was defined as having three or more criteria according to modified WHO[19] criteria adapted for children, which was used by Grundy[23]:

Table 1
Distribution of the study sample.

Age group	Sex	N	Obese		Overweight	
			N	%	N	%
Prepubertal	Boys	874	30	3.4	66	7.6
	Girls	1209	92	7.6	151	12.5
	Total	2083	122	5.9	217	10.4
Pubertal	Boys	1779	144	8.1	177	9.9
	Girls	1929	196	10.2	244	12.6
	Total	3708	340	9.2	421	11.4
Total		5798	462	8.0	638	11.0