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Prevalence of metabolic syndrome and insulin resistance among Egyptian adolescents 10 to 18 years of age

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BACKGROUND: The prevalence and magnitude of childhood obesity are increasing dramatically.

OBJECTIVES: To examine the effect of varying social, demographic, dietary, and activity factors on the prevalence of metabolic syndrome and its relation to insulin resistance, C-reactive protein, and homocysteine levels in a large, representative sample of Egyptian adolescents.

METHODS: Our survey included 4250 adolescents (from 10 to 18 years of age; male subjects comprised 42.5% of participants) from 7 governorates representing Egypt. Baseline measurements included blood pressure, fasting blood glucose, plasma lipids, C-reactive protein, and homocysteine levels. Because the body mass index varies according to age, we standardized the value for age and sex with the use of conversion to percentiles.

RESULTS: The overall prevalence of the metabolic syndrome was 7.4% with no sex or area of residence predilection. Results showed that adolescents with the full criteria of metabolic syndrome (ie, three criterion or more) constituted nearly one fourth of those exhibiting high values of different components, except for systolic blood pressure, where they were 42%, and TG, where they were 31%. Family history of obesity and diabetes mellitus increase the odds for metabolic syndrome significantly (1.68 and 1.3, respectively) as well as inactivity. A high level of C-reactive protein was reported among affected adolescents. Homocysteine level did not have an influence.

CONCLUSIONS: The prevalence of the metabolic syndrome is considerable among obese adolescents. Proinflammatory markers associated with an increased risk of adverse cardiovascular outcomes are already present in these youth.

Chronic noncommunicable diseases (NCDs) are a global challenge. During the next several decades, NCDs will govern the health-care needs of populations in most low- and middle-income countries because of changes in lifestyle factors.[1] Its prevalence is presenting a growing economic and social challenge for many developed and developing countries. According to World Health Organization estimates, by the year 2020, NCDs will account for approximately three quarters of all deaths in the developing world.[2]

Obesity is a major risk factor for chronic diseases and plays a central role in the "insulin resistance" or "metabolic" syndrome, which includes hyperinsulinemia, hypertension, hyperlipidemia, type II diabetes mellitus, and an increased risk of atherosclerotic cardiovascular disease.[3] The metabolic syndrome (MetS) is a common pathophysiologic condition, with implications for the development of many chronic diseases. Obesity beginning in childhood

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often precedes the hyperinsulinemic state.[4] In this regard, a potential emerging public health issue for developing countries may be the increasing incidence of childhood obesity and, as a result, new cases of MetS among children, which in turn is likely to create an enormous socioeconomic and public health burden for poorer nations in the near future.[3]

The MetS has not been well characterized in children and adolescents in terms of criteria, prevalence, or clinical implications, although studies have examined MetS abnormalities.[6] A number of definitions for MetS currently exist in the pediatric population, and most of them include similar metabolic variables but have different cutoff points as to when the variable becomes a risk factor.[6] Chen and Berenson[7] suggest that MetS is found in ~ 4% to 5% of children and adolescents in population-based studies and in up to 49% of severely obese youth. A few studies[8,9] conducted in developing countries have shown a considerably high prevalence of the MetS among youth. Although emerging evidence suggests that children who have the MetS are at increased risk of developing adverse events later in life, more must be learned about the possible health consequences of having MetS in childhood or adolescence. No report exists regarding the prevalence of the MetS in adolescents in Egypt. Therefore, the aim of this work was to examine the effect of varying social, demographic, dietary, and activity factors on the prevalence of MetS and its relation to insulin resistance and to C-reactive protein (CRP) and homocysteine levels in a large, representative sample of Egyptian adolescents.

Table 1 Definitions of risk for metabolic syndrome components

Component	Categories	Risk category definition
BMI	Not at risk	<85th percentile
	Overweight	≥85th to <95th percentile
OR	Obese:	≥95th percentile
Waist circumference	Not at risk	<75th percentile
	At risk	≥75th to 90th percentile
	Obese	≥90th percentile
HDL cholesterol	Normal	>40 mg/dL
	Low	≤40 mg/dL
Triglycerides	Normal	≤110 mg/dL
	High	>110 mg/dL
Fasting Glucose	Normal	<100 mg/dL
	Impaired	100–125 mg/dL
	Diabetes	≥126 mg/dL
	Cut off	≥**110** mg/dL
Systolic or diastolic BP	Normal	<90th percentile
	Pre-hypertension	≥90th to <95th percentile
	Hypertension	≥95th percentile
HOMA-IR (>2.5)	Normal	<2.5
	High	>2.5

BP, blood pressure; HDL, high-density lipoprotein; HOMA-IR, homeostasis model assessment of insulin resistance; OR, odds ratio.

Subjects and methods

This study is a part of a national Egyptian survey: Diet, Nutrition, and Prevention of Chronic NCDs, carried out by teams of the National Nutrition Institute during the years 2004 to 2008. This is a probabilistic, multistage, stratified, cross-sectional study representative of preparatory and secondary school students. Three governorates were randomly chosen from Upper Egypt (Aswan, Sohag, and El-Menia) and three from Lower Egypt, (Ghariba, Kaliobia, and Kafr El-Shikh). Giza governorate was chosen as a metropolitan governorate. Three types of questionnaires were used (medical, dietary, and social) by the project management team to cover topics related to obesity, diabetes, hypertension, and level of physical activity.

Of 6018 adolescents, 4252 were assessed by measuring their fasting blood glucose levels. The criteria for the MetS in adults developed by the National Cholesterol Education Program[10,11] were modified and devised by Lambert et al,[12] de Ferranti et al,[13] and Cook et al[5] as a child-specific definition; it includes abnormalities in any three of the following factors: fasting glucose level (>110 mg/dL), triglyceride (TG) level (>110 mg/dL), high-density lipoprotein cholesterol (HDL-C) level (<40 mg/dL), systolic or diastolic blood pressure (>90th percentile), and body mass index (BMI >85th percentiles; Table 1).

A subsample including 362 students was selected for fasting insulin analysis and insulin resistance assessment by use of the "Homeostasis Model Assessment" (homeostasis model assessment of insulin resistance [HOMA-IR]). Insulin resistance, defined as a HOMA-IR >2.5 was added to test its impact on the prevalence of the MetS.

Procedures

Subjects were evaluated early in the morning, after a 12-hour, overnight fast. Medical assessments were performed, including 1) a family history of chronic NCDs, pattern of physical activity, and symptoms covering various systems; and 2) a general examination including blood pressure measurements. Blood pressure was measured three times while the subjects were seated, and the last two measurements were averaged for analysis. High blood pressure in children is diagnosed by the use of a statistical scale that adjusts the measured blood pressure for factors such as height, weight, and age and compares the adjusted number to a set of averages. With the use of this modified system, high blood pressure in children was diagnosed according to the following rules[14]:

- normal blood pressure: systolic and diastolic pressures <90th percentile;