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Serum magnesium status among obese children and adolescents

Ali M. Zaakouk [a], **Mohammed A. Hassan** [a], **Omar A. Tolba** [b,*]

[a] *Department of Pediatrics, Al-Azhar University, Egypt*
[b] *Cairo University Children's Hospital, Department of Pediatrics, Cairo University, Egypt*

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KEYWORDS

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Obesity;
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Abstract *Background and objectives:* Serum magnesium is involved in the pathogenesis of obesity and its related diseases. The aim of the present study was to evaluate serum magnesium status in obese children and adolescents and to study its relationship with the degree of obesity and serum lipid profile.
Design and settings: A cross-sectional study was conducted at the general pediatric out-patient clinic of a university hospital, over a period of 5 months from May to September 2013.
Methods: 50 obese subjects of ages 2–16 years and 50 healthy normal weight subjects of matched age and sex as controls were consecutively enrolled. Comprehensive history, anthropometric measurements and blood pressure were taken. BMI and degree of obesity were calculated. Fasting total serum magnesium, total cholesterol, LDL-cholesterol, HDL-cholesterol and triglycerides were measured.
Results: Obese cases compared to normal weight controls showed significantly lower serum magnesium and HDL-cholesterol levels and significantly higher total cholesterol, LDL-cholesterol, triglycerides, systolic and diastolic blood pressures. Serum magnesium showed a significant, strong inverse correlation with the degree of obesity ($r = -0.8$, $p < 0.001$); significant, moderate inverse correlation with total cholesterol and LDL-cholesterol; and non-significant correlation with triglycerides and HDL-cholesterol. The degree of obesity showed a significant, moderate positive correlation with total cholesterol and LDL-cholesterol and a non-significant correlation with triglycerides and HDL-cholesterol.
Conclusion: Serum magnesium levels are inversely correlated with the degree of obesity, and is related to an unfavorable serum lipid profile in obese children and adolescents, who also show a trend to higher systemic blood pressure.

* Corresponding author at: Department of Pediatrics, Cairo University Children's Hospital, Cairo University, 50 Lebanon Street, El Mohandessin, 12411 Giza, Egypt. Tel.: +20 1222101717, +20 233025539.
E-mail addresses: alizaakook@hotmail.com (A.M. Zaakouk), mapissar@gmail.com (M.A. Hassan), omartolba80@yahoo.com (O.A. Tolba).
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Introduction

Overweight and obesity are increasingly common among children and adolescents all over the world[1] and in fact Egypt is encountering the double burden of malnutrition.[2,3] The growing prevalence of childhood obesity has also led to appearance of obesity-related comorbid conditions at an early age.[4]

Obesity is a complex, multifactorial condition in which excess body fat may put a child or adolescent at risk of serious health problems such as dyslipidemia, hypertension, diabetes mellitus, and cardiovascular diseases.[4–6]

These complications of obesity are attributed to various inflammatory sialoproteins secreted from the adipocytes mass.[7] The newly identified function of the adipocytes has progressed from a simple energy storage tissue to a major endocrine system. The hormones secreted from adipose tissue influence energy homeostasis, glucose and lipid metabolism, vascular homeostasis, immune response, and reproductive functions.[8] Moreover, obesity is associated with oxidative stress [9], which in association with systemic inflammation affects both insulin secretion and its action, thus resulting in poor glycemic control.[10] In addition, there exist an influence of various inflammatory sialoproteins secreted from the adipocyte mass on insulin resistance (IR), serum lipids and glycemic control.[11,12]

Magnesium (Mg) deficiency is a frequent association in patients with the main risk factors, hyperlipidemia, hypertension, diabetes, and obesity.[8,13]

Magnesium is a vital divalent metal ion and a cofactor for several enzymes involved in the metabolism of fats, proteins and carbohydrates, and also assists the action of insulin.[14] Mg is necessary for the activity of lecithin cholesterol acyltransferase and lipoprotein lipase, which lowers triglyceride levels and raises HDL-cholesterol levels. Mg (2+)-ATP is also the controlling factor for the rate-limiting enzyme in the cholesterol biosynthesis.[13] It plays a significant role in glucose and insulin metabolism, mainly through its impact on tyrosine kinase activity, by transferring the phosphate from ATP to protein. It may also affect phosphorylase *b* kinase activity by releasing glucose-1-phosphate from glycogen. In addition, Mg may directly affect glucose transporter protein activity 4, and help to regulate glucose translocation into the cell.[15] Moreover, studies have shown the association of hypomagnesemia with oxidative stress.[16]. However, supportive evidences whether hypomagnesemia is a cause or an effect, are not yet available.

Several studies linked obesity with a low serum Mg and it has been speculated that Mg deficiency is one of the causes for the above-mentioned disorders,[7,13,17] yet the relationship between Mg and obesity is still unclear.[18]

Serum Mg exhibits a good correlation with intracellular free Mg measured by nuclear magnetic resonance spectroscopy,[19] and total serum Mg concentration is an established biomarker of Mg status.[15,20]

The aim of the present study was to evaluate serum magnesium status in obese children and adolescents and to study its relationship with the degree of obesity and serum lipid profile.

Patients and methods

Study design

A cross-sectional study was conducted at the general pediatric out-patient clinic of Bab-El-Shaeria Hospital, Al-Azhar University-Cairo, Egypt, over a period of 5 months from May to September 2013. The study was approved by the local Ethics Committee. Informed parental consent was obtained prior to enrollment in the study.

Study population

A sample of 100 candidates were consecutively enrolled: 50 obese subjects with BMI $\geqslant 95^{th}$ centile for-age and gender as per Egyptian Growth Charts 2002,[21] aged between 2–16 years; and 50 healthy non-obese subjects with BMI 5^{th} - $< 85^{th}$ centile of matched age and sex as controls. Cases with genetic disease or medical syndromes; diabetes mellitus; other endocrinal disturbances; and/or medical conditions or on medications predisposing hypomagnesemia (e.g. gastroenteritis, chronic kidney disease, chronic liver disease, diuretics and amphotericin) were excluded. Overweight subjects with BMI 85^{th} - $< 95^{th}$ centile were not included.

Methods

History

All candidates were subjected to comprehensive history-taking including detailed dietary history using a validated food frequency questionnaire (based on 24-h recall); family history of obesity or metabolic disorders; and full medical and medicinal history. Enrollment of cases and controls was done simultaneously to avoid seasonal bias in dietary characteristics.

Clinical examination

A detailed clinical examination was performed including anthropometric measurements and blood pressure (BP) using calibrated measuring equipment. In addition, weight for height indices were calculated to assess weight status and the degree of obesity.

Anthropometric measurements: Height, weight, and waist circumference were measured while the subjects were lightly clothed and without shoes. Measurements were conducted using a digital weighing scale, wall-mounted stadiometer, and non-elastic tape measure. The results were recorded to the nearest 0.1 kg, 0.1 cm, and 0.5 cm, respectively, and compared with appropriate Egyptian growth charts 2002.[21]

Weight for height indices: Weight-height indices including body mass index (BMI) and percent ideal body weight (%IBW) to assess weight status and the degree of obesity, being the most commonly used both clinically and in population studies.[22–24] BMI-for-age is the appropriate method for IBW calculation that can be applied consistently to all subjects of ages between 2 and 20 years.[24]

BMI was calculated for each subject as weight (in kilograms) divided by height (in meters) squared (kg/m^2). The readings were plotted on age- and gender-specific percentiles