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Serum and urinary selenium levels in obese children: A cross-sectional study

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ABSTRACT

Objective: To determine serum and urinary selenium (Se) levels in children with and without obesity, and to assess if Se influences the risk of obesity.
Subjects and methods: High-resolution-continuum source-atomic absorption spectrometry (HR-CS-AAS) was used to determine the content of Se in 80 children (age 6–17; 40 boys, 40 girls). Correlations between variables were tested with the use of Spearman's correlation coefficient. *U* Mann–Whitney test was applied to assess the difference of Se contents in samples. Measured metabolic risk factors (blood pressure, glucose level, triglycerides (TG), low-density lipoprotein (LDL), high-density lipoprotein (HDL), and total cholesterol), age, gender, and BMI were correlated. Logistic regression models were fitted to identify predictors of obesity interacting with selenium content in serum and urine, separately.
Results: Obese children, regardless of gender, had lower Se content. Se level in serum ($p = 0.001$, OR 0.74, 95%CI 0.62–0.88) and total cholesterol ($p = 0.001$, OR 1.19, 95%CI 1.08–1.31) were the independent factors significantly influencing the risk of obesity in children. Two separate models were observed for Se in urine: (i) Se level ($p < 0.0001$, OR 0.70, 95%CI 0.58–0.84) and glucose level ($p < 0.0001$, OR 1.22, 95%CI 1.10–1.35), and (ii) Se level ($p = 0.002$, OR 0.60 95%CI 0.43–0.83) and total cholesterol level ($p = 0.003$, OR 1.16, 95%CI 1.05–1.28).
Conclusion: The current study suggests a possible role of Se in obesity. Further research needs to be performed to check if obese children are an at-risk group for Se deficiency.

Introduction

Childhood obesity has become a rapidly growing worldwide problem. It is known that both genetic and environmental factors play a role in the development of obesity. This serious disease process is associated with increased morbidity and mortality in adult life and with several adverse consequences in childhood such as insulin resistance, type 2 diabetes, dyslipidemia, polycystic ovarian syndrome, pulmonary, orthopaedic, and psychological disorders. However, studies of Lloyd et al. [1] do not fully support the view that childhood obesity is an independent risk factor for adult metabolic syndrome or type II diabetes. Moreover, according to the authors, those who are at the lower end of the BMI range in childhood, but continue to be obese during adulthood seem to be at particular risk of metabolic syndrome. Childhood obesity has been linked to obesity in adulthood. It has been reported that 40% of overweight children will continue to be overweight into adolescence and 75–80% will be obese as adults [2]. In a study conducted on 2916 primary school children (1445 girls and 1471 boys) the prevalence of overweight Polish children (including obesity) was found to be 15.4% (15.8% girls and 15.0% boys) while the prevalence of obesity was 3.6% (3.7% girls and 3.6% boys) [3].

Published research reveals that dietary deficiencies for certain trace elements may increase the absorption of toxic metals by certain tissues. Children on low-protein diets, with parenteral nutrition, patients with chronic diseases or with oncologic disorders are especially at risk for the development selenium deficiency [4]. A study of Tascilar et al. suggests no significant difference between groups of obese and non-obese children

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Table 1
Biochemical data and Se levels in the studied and the control groups.

	Average concentration ± SD			
	Controls		Obese	
	Girls $n = 20$	Boys $n = 20$	Girls $n = 20$	Boys $n = 20$
Fasting blood sugar (mg/dL)	75.4 ± 2.8	76.1 ± 4.1	89.9 ± 6.7	88.8 ± 2.2
Triglyceride (mg/dL)	80.7 ± 10.3	86.9 ± 18.2	102.8 ± 12.3	125.1 ± 14.1
Low-density lipoprotein (LDL) (mg/dL)	73.0 ± 4.5	88.4 ± 6.9	102.0 ± 4.8	121.3 ± 4.3
High-density lipoprotein (HDL) (mg/dL)	59.3 ± 5.7	53.6 ± 7.9	48.4 ± 10.7	49.7 ± 6.9
Total cholesterol (mg/dL)	148.4 ± 12.9	159.4 ± 10.6	171.0 ± 9.4	196.1 ± 16.1
Blood pressure (systolic/diastolic) (mmHg)	114.4 ± 2.5/75.4 ± 3.4	110.5 ± 1.6/76.4 ± 6.2	126.2 ± 10.5/79.3 ± 9.4	117. ± 10.2/76.3 ± 4.7
Selenium in serum (μg/l)	102.3 ± 7.9	111.1 ± 9.5	80.4 ± 8.2	82.8 ± 10.3
Selenium in urine (μg/l)	55.9 ± 9.4	60.3 ± 11.5	36.0 ± 7.5	36.7 ± 5.6

regarding selenium serum levels [5]. According to Bouglé et al. obese children are not prone to trace element deficiency [6]. Generally, data from Poland concerning trace elements content in obesity is scarce. In our previous study [7] conducted on Polish children, we found significant differences between the content of metals in obese and healthy children: Zn in serum from obese patients of both sexes, and Zn, Co, and Mn in blood, Mn in serum. Negative correlations between body mass index (BMI) and Zn in blood, Cu in serum, and Fe in urine were discovered for girls (control group), while positive correlation between Co content in serum and BMI was discovered for obese boys.

It is known that people who are overweight or obese commonly experience poorer antioxidant protection, and oxidative stress levels are elevated in obesity [8,9]. Se has antioxidant properties and its protective role against oxidative damage plays an important role e.g. in diabetic complications [10]. Children with excess weight have a poorer selenium status than children of normal weight [11]. Specific correlations have been found between selenium nutritional status and metabolic risk factors in a group of men with visceral obesity [12]. Selenium supplementation in patients with type 2 diabetes may be associated with adverse effects on blood glucose homeostasis, even when plasma Se concentration are raised from deficient status to the optimal concentration of antioxidant activity [13]. Other studies suggest that serum Se level is significantly reduced among morbidly obese female patients seeking bariatric surgery [14]. An association between Se and cardiovascular disease, which is the main outcome of metabolic syndrome, was reported in literature [15]. Activity of enzymes, which prevent the peroxidation of low-density cholesterol, is associated with Se content in the body. The question of whether Se protects against cancer seems to be still open, however, to date, there is no convincing evidence that selenium supplements can prevent cancer [16]. However, epidemiological data has also shown a significant association between obesity and a number of cancers [17,18]. Thus, investigations on the Se content in obesity deserve attention.

There has been considerable interest in studying the content of trace elements in various biological fluids, although it is influenced by many factors (e.g. age, sex, diseases, drugs, diet supplements, nutritional habits, lifestyle factors, etc.). This work was undertaken to estimate Se levels in serum and urine of obese and healthy children, to correlate Se status with BMI, age, sex, lipid profile, glucose, and blood pressure, and to assess if Se influences the risk of obesity.

Methods

Subjects

The studied group of children were admitted to the Department of Paediatric Endocrinology and Diabetology, Medical University of Lublin, Poland for further diagnostic testing related to their obesity. Patients and control group were from the same geographic area (Lublin region, south-east Poland). The non-obese children were present for routine check-ups. Informed consent was obtained from the parents. The study was approved by the Ethics Committee of the Medical University of Lublin. Tests were performed in 80 children who constituted two groups: obese (20 girls and 20 boys, age 6–17 y, the average age: 13.1 y) and the control group (20 girls and 20 boys, age 8–17 y, the average age: 13.5 y). In the obese group of patients, the overall mean height for boys was 162.6 cm, and for girls 154.6 cm; weight was for boys were 82.3 kg, for girls 72.2 kg. Boys had a higher mean BMI (37.7 kg/m^2) than girls (29.7 kg/m^2). In the control group, the mean values for boys were 161.6 cm, 52.8 kg, 20.13 kg/m^2, and for girls: 160.1 cm, 52.9 kg, and 20.4 kg/m^2. BMI was calculated using the formula (weight in kg)/(height in m)^2. A BMI in the 95th percentile or higher was considered obese. According to the interviews with the parents, within 6 months before the study, the children did not take any vitamins, dietary supplements, medication and they were not on any special diets. None of the children reported cigarette smoking. Chronic and acute inflammatory processes were excluded based on physical examination and basic laboratory analysis. Blood and urine samples were drawn after an overnight fast. Biochemical parameters measured using commercial kits are listed in Table 1. An automatic device measured blood pressure in the morning before eating. Blood was collected in EDTA vacutainers. Samples were kept on ice and centrifuged within 3 h of collection. Aliquots of serum were stored at −25 °C until analysis. Casual morning urine samples were collected in clean plastic specimen containers and stored at −25 °C until analysis.

Samples, reagents, and instruments

The studied material consisted of 160 samples of human serum and urine. Samples taken from healthy and obese patients were pre-treated and analyzed in the same way. They were transported and stored in polypropylene containers. 1 mL of each type of sample was divided in two parts (each 0.5 mL) in order to have two independent solutions prior to the mineralization procedure. A microwave-assisted high pressure digestion system (UniClever BM-1, Plazmotronika, Poznań, Poland) was used. Each time an acidic digestion with 65% nitric acid water solution was applied (1 mL of HNO_3: 9 mL of deionized H_2O). The conditions of the mineralization procedure had been previously optimized [19]. The obtained solutions were poured into volumetric flasks (PTFE) and when it was necessary, they were diluted with deionized water (18 MΩ cm) before final analysis. After the mineralization, each sample was analyzed at least in triplicate using high-resolution atomic absorption spectrometer. The measurements were performed with the ContrAA700 high-resolution continuum source graphite tube AAS instrument (Analytik Jena AG, Jena, Germany). A transversely heated graphite furnace was