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Article / Review

HYPOXIA IN CHILDREN AND ITS IMPACT ON METABOLISM

Sh.M.Ibatova[1]

1. Samarkand State Medical University, Samarkand, Uzbekistan.

Abstract.

Relevance. According to the World Health Organization, the number of overweight and obese children continues to increase, posing a serious threat to the public health system. Scientific studies indicate that malnutrition and intrauterine hypoxia can affect the mechanisms of neuroendocrine regulation in the fetus. **Objective of the study.** To study the main risk factors for the development of metabolic disorders in children who have experienced hypoxia. **Materials and methods.** The study involved 55 adolescents suffering from exogenous constitutional obesity combined with arterial hypertension. Participants were selected taking into account the body mass index (BMI) and waist circumference exceeding the 97th percentile. Determination of the level of total cholesterol and high-density lipoproteins (HDL) in the blood serum was carried out by the enzymatic method, and the concentration of triglycerides was measured using the colorimetric method according to the modified Gottfried and Rosenberg method. **Results of the study and their discussion.** In the examined children, BMI exceeded the 97th percentile, averaging 31.27 ± 0.51 kg/m² (range, 23.5–47.2 kg/m²). In Group I, the mean BMI was 28.85 ± 0.52 kg/m² and in Group II, 35.37 ± 0.63 kg/m² (P<0.01). Lipid profile parameters showed significant deviations in obese patients. Triglyceride levels exceeded the norm in 29.4%, 30%, and 38.8% of children in Groups I, IIA, and IIB, respectively. Mean fasting glucose levels remained within the normal range (p<0.05), but insulin resistance was detected. The concentration of fasting and postprandial glycemia (p<0.05) was significantly higher than the values in the control group and increased with the progression of obesity. Elevated fasting glucose levels were observed in 17.6%, 20%, and 27.7% of children in groups 1, 2a, and 2b, respectively. Similarly, an increase in postprandial glycemia was detected in 5.8%, 15%, and 22.2% of children. When studying LDL cholesterol fractions, its level was 3.04±0.23, 3.66±0.18, and 4.14±0.39 mmol/l. Elevated values were noted in 29.4%, 35% and 44.4% of children. The studies revealed a decrease in the level of high-density lipoproteins (HDL) in 17.6%, 25% and 22.2% of the examined children in groups 1, 2a and 2b, respectively. **Conclusions.** It was found that birth weight and body mass index in adolescence have an inverse correlation, which indicates the significance of low birth weight as a predictor of obesity and metabolic syndrome in the future. The results emphasize the importance of early detection and correction of risk factors, including weight control from the first days of life.

Key words: metabolic disorders, obesity, arterial hypertension, body mass index, lipid metabolism, carbohydrate metabolism, prevention.

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Correspondence
Ibatova Shoira Mavlanovna,
Samarkand State Medical University, Samarkand, Uzbekistan.

e-mail: sh.ibatova@mail.ru

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Introduction

Modern medicine is faced with a large-scale problem of obesity, affecting people of all ages, including children and adolescents [1-5]. According to the World Health Organization (WHO), the number of children with overweight and obesity continues to increase, posing a serious threat to the public health system [7,15,16]. Already in 2010, about 43 million children with excess weight were recorded worldwide, which emphasizes the severity of this problem [11,13,17]. Obesity rarely manifests itself as an isolated condition and is often accompanied by serious metabolic and cardiovascular dysfunctions. In particular, arterial hypertension (AH) is diagnosed in 0.4–8% of children and adolescents, significantly increasing the likelihood of developing cardiovascular diseases in adulthood. An important factor contributing to the progression of AH is hyperuricemia, which, in combination with obesity, worsens the general condition of the patient [3,6,9].

Scientific research indicates that malnutrition and intrauterine hypoxia can affect the mechanisms of neuroendocrine regulation in the fetus. These changes affect the functioning of the hypothalamic-pituitary-adrenal system, which may predispose to metabolic disorders such as insulin resistance and metabolic syndrome in the future [6,8,10,12]. Of particular interest is the study of risk factors associated with early

childhood. Studies indicate an inverse correlation between birth weight and body mass index (BMI) in adolescence [7,11,15,16]. Low or, conversely, excessively high birth weight can become a predictor of obesity and metabolic disorders in the future. In this regard, special attention should be paid to monitoring body weight from birth, as well as the formation of healthy eating habits from the first years of life.

Purpose of the study. The aim of the study was to investigate the main risk factors for the development of metabolic disorders in children who have experienced hypoxia.

Materials and methods of the study. The study involved 55 adolescents suffering from exogenous-constitutional obesity in combination with arterial hypertension. Participants were selected taking into account the body mass index (BMI) and waist circumference exceeding the 97th percentile. The sample included 25 girls (45%) and 30 boys (55%) with an average age of 14.35 ± 0.21 years (range, 10 to 18 years). The average waist circumference (WC) was 99.82 ± 1.3 cm, and the WC/HC ratio was 0.92 ± 0.009. Total cholesterol and high-density lipoprotein (HDL) levels in the blood serum were determined by an enzymatic method, and the concentration of triglycerides was measured using a colorimetric method according to a modified method of Gottfried and Rosenberg (1973).

Results and discussion. The examined children had BMI above the 97th percentile, averaging 31.27 ± 0.51 kg/m² (range, 23.5 to 47.2 kg/m²). In Group I, the average BMI was 28.85 ± 0.52 kg/m², and in Group II, 35.37 ± 0.63 kg/m² (P<0.01). The control group had an average BMI of 19.44 ± 0.47 kg/m² (P<0.001). A statistically significant positive correlation was observed between the increase in WC and the degree of obesity (p = 0.01). Of the examined children, 20 had normal blood pressure (Group IIA), and 18 had a confirmed diagnosis of arterial hypertension (Group IIB).

The control group included 20 children without obesity, whose average age was 14.31 ± 0.63 years. Their waist circumference was significantly lower (64 ± 1.51 cm), and the WC/HC ratio was 0.81 ± 0.02, which was statistically significantly different from similar indicators in children with obesity (P < 0.01 for group I and P < 0.001 for group II). The control group included 9 girls and 11 boys. Arterial hypertension was diagnosed in 18 children with obesity. The average blood pressure in this group was: systolic - 138.7 ± 7.2 mm Hg, diastolic - 94.5 ± 6.5 mm Hg (P < 0.05). The WC/OB ratio turned out to be a reliable marker of abdominal obesity, with its values >0.85 in girls and >0.9 in boys. Lipid profile indices demonstrated significant deviations in obese patients. Triglyceride levels were above the norm in 29.4%, 30%, and 38.8% of children in groups I, IIA, and IIB, respectively. On average, it was 1.56 ± 0.25, 1.92 ± 0.16, and 2.3 ± 0.23 mmol/l (in groups I, IIA, and IIB, respectively). Total cholesterol levels were elevated in 35.2%, 35%, and 44.4% of children (in groups I, IIA, and IIB), amounting to 4.56 ± 0.58; 5.01 ± 0.33 and 5.76 ± 0.52 mmol/l, respectively.

Average fasting glucose levels remained within normal limits (p<0.05), but insulin resistance was detected. Postprandial glycemia increased significantly as obesity progressed. In particular, increased fasting glucose was observed in 17.6%, 20% and 27.7% of children (in groups I, IIA and IIB), postprandial hyperglycemia - in 5.8%, 15% and 22.2%, respectively.

The onset of the disease in boys averaged 8.3±0.5 years, while in girls it was 7.4±0.3 years. When assessing physical development, it was found that 47% of children with a uniform type of obesity were tall. Skin changes in the form of stretch marks from pale pink to burgundy were observed in 29.4% of children, and acanthosis nigricans in 11.7%.

Analysis of carbohydrate metabolism parameters revealed that the average levels of glycemia (fasting and postprandial glucose) in the main groups corresponded to the norm (p<0.05), but indicated the presence of insulin resistance. The concentration of fasting and postprandial glycemia (p<0.05) was significantly higher than the values of the control group and increased with the progression of obesity. Elevated fasting glucose levels were observed in 17.6%, 20%, and 27.7% of children in groups 1, 2a, and 2b, respectively. Similarly, elevated postprandial glycemia was detected in 5.8%, 15%, and 22.2% of children.

When analyzing triglyceride levels, it was found that 29.4%, 30%, and 38.8% of the subjects suffered from triglyceridemia. The average triglyceride levels were 1.56±0.25, 1.92±0.16, and 2.3±0.23 mmol/l (in groups 1, 2a, and 2b). Elevated total cholesterol values were detected in 35.2%, 35% and 44.4% of cases, and its level in the groups with abdominal obesity was significantly higher than in the control group (4.56±0.58;

5.01±0.33 and 5.76±0.52 mmol/l).

When studying LDL cholesterol fractions, it was found that its level was 3.04±0.23, 3.66±0.18 and 4.14±0.39 mmol/l. Elevated values were noted in 29.4%, 35% and 44.4% of children.

Analysis of uric acid (UA) concentration showed that its level did not exceed the norm, but was significantly higher than in the control group. A direct correlation was found between the UA level and the degree of obesity (r=0.592, p<0.001), as well as the blood pressure level (r=0.446; r=0.369; p<0.001). In children with uniform obesity, the UA level reached 0.324±0.011 mmol/l, while in the control group it was 0.180±0.013 mmol/l (P<0.01). The studies revealed a decrease in the level of high-density lipoproteins (HDL) in 17.6%, 25% and 22.2% of the examined children in groups 1, 2a and 2b, respectively. The average HDL values were 1.22±0.12; 1.13±0.09 and 1.03±0.07 mmol/l.

Data on biochemical parameters in children with different degrees of obesity are presented in the table.

Table-1

Biochemical parameters in children with different degrees of obesity

Indicator	1 group (normal)	2a group (overweight)	2b group (abdominal obesity)
Average blood glucose level (mmol/L)	4,8 ± 0,2	5,1 ± 0,3	5,5 ± 0,4
Elevated fasting glucose (%)	17,6%	20%	27,7%
Elevated postprandial blood glucose (%)	5,8%	15%	22,2%
Triglyceride level (mmol/L)	1,56 ± 0,25	1,92 ± 0,16	2,3 ± 0,23
Elevated cholesterol (%)	35,2%	35%	44,4%
LDL level (mmol/L)	3,04 ± 0,23	3,66 ± 0,18	4,14 ± 0,39
Uric acid level (mmol/L)	0,18 ± 0,013	0,324 ± 0,011	0,324 ± 0,011

Conclusions

The conducted studies confirmed the existence of a relationship between the body mass index, lipid and carbohydrate metabolism parameters, and key risk factors. It was found that birth weight and body mass index in adolescence have an inverse correlation, which indicates the significance of low birth weight as a predictor of obesity and metabolic syndrome in the future. The obtained results emphasize the importance of early detection and correction of risk factors, including weight control from the first days of life and the formation of healthy eating habits from childhood.

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