

Article/Original paper

MICROALBUMINURIA AS AN INDICATOR OF METABOLIC DISORDERS IN OBESITY CHILDREN

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Abstract.

The original article presents the results of a study of the relationship between microalbuminuria and carbohydrate and lipid metabolism parameters in children with obesity. The results of the study are recommended for widespread implementation in the practical activities of general practitioners and pediatricians. **Research objective:** To determine the relationship between microalbuminuria and carbohydrate and lipid metabolism parameters in children with obesity. **Materials and methods:** 55 children with primary exogenous constitutional obesity aged 7 to 18 years, as well as 20 children with normal body weight were studied. A set of anthropometric, clinical, and biochemical studies was conducted. **Results of the study:** a relationship was found between the degree of obesity and the severity of carbohydrate metabolism disorders and dyslipidemia in children, which was expressed in an increase in the level of cholesterol, triglycerides, LDL and a decrease in HDL, an increase in immunoreactive insulin and an increase in the IR HOMA R index. The study showed a relationship between the pathological level of urine albumin and the degree of pathology of carbohydrate and lipid metabolism, which indicates a significant contribution of the degree of metabolic disorders to the pathology of the functional capacity of the kidneys. **Conclusion:** in obesity, the kidneys are one of the first and main target organs most susceptible to damage, since they are the first to take on the function of correcting metabolism with an increase in the volume of adipose tissue. Thus, patients with excess accumulation of fat mass in the body should be considered as a group at very high risk of developing chronic kidney disease.

Key words: obesity, children, carbohydrate metabolism, lipid metabolism, microalbuminuria.

Introduction: At the present stage, childhood obesity has become a worldwide epidemic. Statistical research results presented by the World Health Organization (WHO) indicate that "...29% of children aged 7 to 9 years are overweight and obese, with 28% in girls and 31% in boys, with a tendency to increase in prevalence with age" [1,3]. The relevance of obesity in children associated with severe disorders, one of which is the early question of the structure of the kidneys, confined to the phase of nephropathy, friendly with metabolic disorders, and an important change to a progressive course. Despite this, there is very little published data on the structural and functional state of the kidneys based on the results of their comprehensive study using modern instrumental diagnostic methods in adolescent children with obesity [4,5].

Currently, the importance of obesity as a predisposing factor in the development of tubulointerstitial kidney damage, in which the primary symptom is microalbuminuria, is widely discussed in the literature [6,7]. In this regard, the study of microalbuminuria in children and adolescents with obesity is of scientific and practical interest and determined the setting of the goals of our study

Purpose of the study: To determine the relationship between microalbuminuria and indicators of carbohydrate and lipid metabolism in obese children.

Material and methods: our research was carried out in family clinics in the city of Samarkand (Uzbekistan). The study involved 55 people aged 7 to 18 years (average age of children 12.03 ± 0.17 years), with overweight and obesity. The control group included 20 practically healthy children with normal body weight and no pathology of the musculoskeletal system.

Anthropometric studies were carried out using standard measuring instruments (floor height

meter and medical scales). Anthropometric measurements include: height, body weight, waist and hip circumference. Comparison of the obtained data and assessment of physical development were carried out using the WHO cumulative centile tables of age and gender distribution of height and body weight for children 5-19 years old [1]. Body mass index (BMI) was calculated from the measurements.

Outcomes were assessed using BMI standard deviations (SDS) according to WHO recommendations [1]. Obesity in children and adolescents should be defined as +2.0 SDS BMI, overweight +1.0 to +2.0 SDS BMI, and underweight -1.0 to -2.0 SDS BMI [1].

Based on anthropometric data and determination of body mass index (BMI, kg/m²) in accordance with gender and age, it was possible to distribute children into 3 groups: Group I 21 children with overweight (SDS +1.0 to +2.0), Group II 18 children with obesity of I-II degree (SDS from +2.0 to >+3), Group III 16 children with a BMI within SDS from +3.0 above, which characterized children with grade 3 obesity and above. The control group consisted of 20 children with BMI SDS -1.0 to +1.0. All children included in the study were residents of the Samarkand region.

Microalbuminuria was determined in morning urine by a semi-quantitative method using visual test strips for microalbuminuria MICRAL-TEST II (Mikral-Test 2) Roche Diagnostics.

The concentration of glucose in blood serum was determined by the glucose oxidase method. Cholesterol (CH), high-density blood cholesterol (HDL) was determined using the enzymatic method. Low-density lipoprotein (LDL) and very low-density lipoprotein (VLDL) cholesterol levels were determined using the Friedwald formulas. The level of immunoreactive insulin (IRI) was determined by enzyme-linked immunosorbent assay (ELISA) with the calculation of HOMAR IR indices using the formulas.

Statistical processing of the obtained data was carried out on a personal computer using the Statistica 10 program. Methods of variational parametric and nonparametric statistics were used to determine the arithmetic mean (M), standard deviation (σ), standard error of the mean (m), relative values (frequency, %). The statistical significance of the obtained measurements was determined by Student's test (t) with calculation of the probability of error (P).

Research results: As can be seen from the presented data, carbohydrate metabolism disorders occurred in all groups with excess body weight, with a significant frequency in the group with grade 3 obesity

When conducting a standard glucose tolerance test, carbohydrate metabolism disorders were detected with the highest frequency in the group with grade 3 obesity (62.5%), where there was also an increase in fasting glucose, occurring in 1/3 of the children in this group (37.5%), impaired glucose tolerance was revealed, which indicated the hidden nature of carbohydrate metabolism disorders in children.

The obtained data were significant in comparison with children with excess body weight both in relation to fasting hyperglycemia ($p < 0.05$) and in relation to impaired glucose tolerance ($p < 0.05$), while in comparison with the results of the group of children with 1 and 2 degrees of obesity, they did not differ.

In children with grade 3 obesity, high glycated hemoglobin was also detected (43.7%), while in some children it was the only lesion in carbohydrate metabolism, which is evidence of a violation of carbohydrate metabolism not detected during the glucose tolerance test. The level of glycated hemoglobin significantly exceeded the values of children in group 1 ($p < 0.01$) and differed from those in group 2 children ($p < 0.01$). (Table 1)

In children with severe obesity, there was a higher frequency of children with high levels of immunoreactive insulin, the level of which did not exceed the reference values, but was an order of magnitude higher compared to the indicators of other sick children. High levels of immunoreactive insulin were found in more than half of the children in group 3 (62.5%), while the IR HOMA R index in 68.7% of cases had values exceeding the threshold value of 3.2, which suggests that despite the level of immunoreactive insulin within the normal range, in combination with a high level of fasting glucose, insulin resistance developed in this category of patients.

Table-1

Comparative analysis of the incidence of carbohydrate metabolism pathology in comparison groups (n (%))

	I group n= 21	II group n= 18	III group n= 16
Fasting hyperglycemia;	2 (9,5)	4 (22,2)*	6(37,5)**
Violation of glucose tolerance	2(9,5)	5(27,7)*	10(62,5)**
High glycated hemoglobin (>7,5%)	1 (4,7)	5(16,7)*	7(43,7)**
Hyperinsulinemia (immunoreactive insulin)	2 (9,5)	8(44,4)*	10(62,5)**
The high index of the IR HOMA R	1(4,7)	9 (50)*	11(68,7)**

Note: * the significance of the difference between group 3 and group 1 **p<0.01; between group 1 and group 2 *p<0.05

It should be noted that both the frequency of hyperinsulinemia and the frequency of high IR HOMA R index were significantly higher both compared to group 1 (p<0.01, respectively), and compared to the second group with 1 and 2 degrees of obesity (p<0.05, respectively).

Of the most common disorders of lipid metabolism, a decrease in the fraction of high-density lipoprotein cholesterol (HDL-C) was noted; it was found that the most common decrease in this indicator occurred in children with a significant excess of body weight from normal values, observed in almost half of the children in this group of children (62.5%), with a significant prevalence of occurrence compared to children with overweight (p<0.01), and compared to children with a body weight corresponding to 1-2 degrees of obesity (p<0.05).

The second type of pathology in terms of frequency of occurrence was hypertriglyceridemia. Similar to the decrease in the level of HDL-C, the frequency of occurrence of this indicator depended on body weight, most often occurring in group 3 (43.7%), which was significantly higher compared to group 1 (p<0.02) and compared to group 2 (p<0.05).

The frequency of occurrence of total cholesterol and the fraction of low-density lipoprotein cholesterol increased depending on the increase in body weight. At the same time, the level of total cholesterol did not differ significantly in the obese groups, while low-density lipoprotein cholesterol had a significant frequency, significantly exceeding the indicators of both children of group 1 (p<0.01) and children of group 2 (p<0.05). (Table 2).

Table-2

Comparative analysis of the incidence of lipid metabolism pathology in children of the comparison groups

	I Group n= 21	II Group n= 18	III Group n= 16
Hypertriglyceridemia	2 (9,5)	4(22,2)	7(43,7)
Hypercholesterolemia	2(9,5)	5(27,7)	8 (27,0)
Low HDL cholesterol	4 (19,0)	6(33,3)	7(43,7)
High levels of LDL cholesterol	5 (23,8)	9 (50)	10 (62,5)

Note: * the significance of the difference between group 3 and group 1 **p<0.01; between group 1 and group 2 *p<0.05

Thus, in children of group 3, changes in the lipid profile of the blood serum were more pronounced atherogenic in nature compared to other groups, where statistically significant differences in the disturbance of the lipid fraction were revealed in groups with different body weights.

When analyzing the quantitative values of metabolic parameters characterizing comorbidity in obesity in children and adolescents, in relation to the severity of obesity, data were obtained on a statistically significant increase in the median of all parameters characterizing lipid metabolism with increasing body weight.

After determining the presence and level of albumin in the urine of all children of the study groups according to the MAU level, we divided them into two subgroups: 1 subgroup MAU up to 20 mg/l, 2 subgroup MAU >20 mg/l.

First of all, we conducted a comparative study of the level of carbohydrate metabolism indicators; it should be noted that in group 1, no statistical dependencies on the level of MAU in the urine and an increase in carbohydrate metabolism indicators were identified.

In group 2, there was a statistically significant increase only in blood insulin ($p < 0.05$), in group 3 there was a statistically significant difference between insulin levels ($p < 0.05$), the HOMA R index ($p < 0.05$) and the level of glucose tolerance test ($p < 0.05$).

Thus, when comparing triglyceride levels in groups with different levels of daily microalbumin excretion in urine ($MAU \leq 20$ mg/l and $MAU > 20$ mg/l in morning urine) in a group of children and overweight, we obtained statistically significant results in cases of triglyceridemia ($p < 0.05$) and high-density lipoprotein cholesterol ($p < 0.05$).

In children of the group with grade 1-2 obesity, we obtained significantly significant differences between the two subgroups for triglycerides ($p < 0.05$), high-density lipoprotein cholesterol ($p < 0.05$) and low-density lipoprotein cholesterol ($p < 0.05$), i.e. all indicators tended to increase, and CLPV to decrease.

In children with grade 3 obesity, statistically significant growth rates were observed for all indicators of lipid metabolism, depending on the level of MAU (triglycerides ($p < 0.01$), high-density lipoprotein cholesterol ($p < 0.01$) and low-density lipoprotein cholesterol ($p < 0.01$) and total cholesterol ($p < 0.01$)).

Obesity is often accompanied by changes in the blood lipid spectrum, impaired glucose tolerance and arterial hypertension [6]. Insulin resistance and hyperinsulinemia play a major role in the development of obesity; under their influence, the activity of triglyceride lipase changes, which slows down the catabolism of lipoproteins and leads to hypertriglyceridemia and dyslipidemia [7].

Dyslipidemia is a known risk factor for atherosclerosis and is also common among adults and children with chronic kidney disease.

Conclusions: a relationship was found between the degree of obesity and the severity of carbohydrate metabolism disorders and dyslipidemia in children, which was expressed by an increase in the level of cholesterol, triglycerides, LDL and a decrease in HDL, an increase in immunoreactive insulin and an increase in the IR HOMA R index. The study showed a relationship between the pathological level of urine albumin and the degree of pathology of carbohydrate and lipid metabolism, which indicates a significant contribution of the degree of metabolic disorders to the pathology of the functional capacity of the kidneys. In obesity, the kidneys are one of the first and main target organs most susceptible to damage, since they are the first to take on the function of correcting metabolism with an increase in the volume of adipose tissue. Thus, patients with excess accumulation of fat mass in the body should be considered as a group at very high risk of developing chronic kidney disease.

Decision of the Ethics Committee of the Samarkand State Medical University: written permission from patients was obtained to conduct the scientific research and the results of the study can be published in scientific journals.

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