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# Frequency of Metabolic Syndrome and Other Complications of Obesity

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**Abstract:** An analysis of 121 medical histories of children with obesity aged 5 to 17 years was conducted. The leading complications and concomitant diseases are: gastropathology (96%), cardiac disorders (50%), metabolic disorders (47%), hypothalamic syndrome (46%), accelerated or accelerated physical development (85%), delayed sexual development in boys (25%), accelerated puberty (60%) and hyperandrogenism in girls (5%). It was found that metabolic syndrome was 1.5 times more common in children with 1-2 degrees of obesity than in children with 3rd degree of obesity. A high incidence of morbidity in children with obesity was revealed, which reflects reduced immunological reactivity of the body.

**Keywords:** obesity, children, adolescent, metabolic syndrome, gastropathology.

Obesity in pediatric practice remains a serious international medical problem, belongs to the group of socially significant diseases, since one of the complications of obesity is metabolic syndrome associated with the risk of developing type 2 diabetes mellitus, arterial hypertension and cardiovascular diseases [1, 2, 10, 11]. According to the endocrinology research center of the Ministry of Health (2017), 13-15% of children in Russia suffer from obesity, with schoolchildren accounting for 5-8%. This number is 2 times higher than the number of children with obesity in France, 1.5 times higher than in England and is approaching the number of children with obesity in the USA (17%). The rate at which the incidence rate is growing, the number of sick children doubles every 30 years, allows us to talk about a threat to national security [3, 7, 8]. A joint task force of the European Society of Endocrine Science and the Paediatric Endocrine Society has issued new joint guidelines for the diagnosis, treatment and, most importantly, prevention of obesity in children and adolescents (Journal of Clinical Endocrinology and Metabolism, 2017). The results of the study of medical records in children and adolescents with obesity are literally "shocking". In terms of the systemic nature of the lesion and the number of organs involved in the pathological process, obesity can be put in second place among endocrine diseases after type 1 diabetes mellitus. When talking about complications of obesity, we always mean adults. Type 2 diabetes mellitus, arterial hypertension, cardiovascular insufficiency, cholecystitis, cholelithiasis, musculoskeletal disorders (osteoarthritis, flat feet, osteoporosis), gout, thromboembolism, sleep apnea syndrome - this is an incomplete list of complications of obesity. For example, in the USA, non-alcoholic fatty liver disease is the most common cause of cirrhosis in adolescents and the most common cause of liver transplantation in adults [4, 5, 9]. Looking at a rosy-cheeked child with obesity, sometimes capricious, disinhibited or whiny, with a good appetite and skin color, not for a moment does the thought arise that behind the outer shell of imaginary health there is liver and heart damage, and his behavior is a consequence of damage to the hypothalamic structures and vegetative parts of the central nervous system [1, 6, 8].

There is no mild obesity, any obesity is “bad”, since even with mild excess weight, pronounced metabolic disorders are sometimes revealed. Doctors have noted that metabolic “signs” “lying on the surface”, such as black acanthosis – dark brown pigmentation with proliferation of skin papillae in the armpits, less often in the neck and inguinal areas (pigment-papillary dystrophy of the skin), waist-to-hip ratio (WHR) of more than 0.85, presence of salts in the general urine analysis (oxalates or urates), deposition of subcutaneous fat mainly on the anterior abdominal wall, arterial hypertension (BP more than 135/80 mm Hg), indicating insulin resistance, are most often found in patients with grades 1–2 obesity. Further in-depth examination revealed dyslipidemia, increased uric acid levels in the blood and urine, and increased glycated hemoglobin. The families of such patients had relatives with various metabolic diseases: type 2 diabetes, hypertension, gout, urolithiasis, and in different age categories, including those under 30. Often, the first visit to the doctor in this group was at the age of 5 and in primary school (7-9 years) and was dictated by a complaint of fat deposition mainly on the abdomen and the parents' anxiety due to a possible "hormonal imbalance" in the child's body, which could affect reproductive function in the future. Further examination, as a rule, excluded somatic, genetic, and endocrine causes of obesity. The fact is that fat accumulates intensively during certain age periods, and one of these periods is 5-7 years. Hypercellularity (an increase in the number of fat cells) occurs during this period. The question arose: is there a correlation between the degree of obesity and the frequency of metabolic signs? Is there a relationship between metabolic disorders in children with a family history? It would seem obvious: more obesity - more likelihood of metabolic syndrome. However, observation showed that a large group of children with significant obesity did not have metabolic shifts in the lipidogram, blood pressure was stable within the norm, black acanthosis and salts in the urine were not detected, obesity was uniform. Two children with excess weight of 20-25% (grade 1 obesity) and visceral obesity came to see a specialist for consultation: WC/HC ratio = 0.98-0.96 (with the norm in children / = 5.2 mmol / l; triglyceride level > 1.3 mmol / l for children under 10 years and > / = 1.7 mmol / l for children over 10 years; high-density lipid (HDL) level / = 3.0 mmol / l. Dyslipidemia is considered in the presence of 2 or more criteria.

**Objective of the work**: To determine complications and concomitant diseases in children with obesity, the rate of development of metabolic syndrome in them and to assess the general immunological reactivity of the body.

**Research methods:** An analysis of 121 medical histories of patients aged 5 to 17 years was conducted. The analysis used the results of a biochemical study: blood for cholesterol, HDL, LDL, triglycerides, uric acid, C-reactive protein, glycated hemoglobin, insulin levels, daily urine for uric acid, oxalates, microalbuminuria, blood pressure data, BMI (body mass index) calculation, WC/HC ratio, examination data (the presence of acanthosis nigricans, in girls - hypertrichosis and polycystic ovary disease), instrumental examination data (ultrasound, ECG).

**Research results and their discussion:** Obesity is predominantly found in girls (67%), and adolescents more often, boys account for 33%. It is noteworthy that 62% of children with grade 1–2 obesity under the age of 10 have metabolic “signs” with a disease history of less than 5 years. In 60% of those examined with metabolic “signs” with grade 3–4 obesity, the disease history was less than 5 years. In total, 77% of children with obesity fall into the age group of 10–16 years, 60% under the age of 14, and 40% older. The predominance of adolescent girls is explained by the fact that during this period, especially in girls, the number of adipocytes increases (the hypercellularity period mentioned above). Adipose tissue plays an important endocrine role: with the help of the aromatase enzyme, it converts testosterone into estrogens, which is especially important during the formation of the menstrual cycle. As is known, menstruation does not occur with low body weight (below 43 kg). In addition to the increase in the number of adipocytes, during puberty, a state of physiological insulin resistance occurs, which contributes to weight gain. According to the degree of obesity, the patients were divided as follows: grade 1 obesity (excess weight up to 25%) - 13 children; grade 2 obesity (excess weight 25-50%) - 54 children; grade 3 obesity (excess weight 50-100%) - 49 children; grade 4

obesity (excess weight over 100%) - 5 children. Metabolic "signs" were detected in 7 children (53%) with grade 1 obesity, in 27 children (50%) with grade 2, in 18 people (36.7%) with grade 3, and in 5 children (100%) with grade 4. In total, metabolic disorders were detected in almost half of the examined patients, 47% (57 children), while the remaining 53% (67 children) had no metabolic disorders. Burdened family history in the group of children with obesity and metabolic disorders, mainly type 2 diabetes mellitus and arterial hypertension, was noted in 36 children (63%). In the group of children with obesity but no metabolic disorders, type 2 diabetes mellitus in close relatives is very rare, occurring in only 5% of cases (3 people), but half of the patients in this group had relatives with simple obesity (50%). Type 2 diabetes mellitus was not detected in any child. A decrease in HDL below 1.0 mmol/l was detected in 30% of patients (every third patient); an increase in LDL above 3.0 mmol/l was noted in 16% of children; an increase in triglycerides above 1.3 mmol/l up to 10 years and 1.7 mmol/l in 14% of children; an increase in the level of uric acid in the blood above 326 μmol/l up to 12 years and above 447 μmol/l over 12 years was noted in 22% of children (almost every fourth patient); an increase in cholesterol above 5.2 mmol/l (range 6.2–7.8 mmol/l) was noted in 8.5% of children; an increase in blood glucose (impaired fasting glycemia) in 15% of children; hypercrystalluria (oxalates, urates), hyperuricemia in daily urine was detected in 18% of children; Microalbuminuria (20–50 mg/l) was detected in 13% of children; increased blood pressure over 135/80 mm Hg (BP range 140–180/90–120 mm Hg) was detected in every fourth patient (24%). According to literature data, the causes of blood pressure are insulin resistance and hyperinsulinemia. Insulin secretion promotes an increase in the tone of the sympathetic divisions of the central nervous system, the mediator of the sympathetic nervous system is adrenaline. A distinctive feature of adipose tissue (it contains beta-adrenergic receptors) in children should be considered a high sensitivity to adrenaline [1, 3]. This explains the high blood pressure. A combination of 2 or more metabolic "signs" was noted in 37% of patients. The most frequent combination of symptoms was hyperuricosemia, microalbuminuria and arterial hypertension. In the group of subjects with a combined elevated level of blood triglycerides and a decrease in the level of high-density lipids, relatives suffer from type 2 diabetes mellitus; in the group with a combined increase in uric acid in the blood and triglycerides, relatives suffer from arterial hypertension. According to the literature, obese children are more likely than healthy children to have an increased level of circulating immune complexes, which predisposes these children to autoimmune diseases [4, 9]. Ultrasound examination of the abdominal organs revealed the following: 88% of children had reactive changes in the pancreas, in 28% of cases, i.e. almost every third child, these changes were combined with reactive changes in the liver; 12% of children had a kink in the gallbladder; 8% of children had gallstones. According to literature data [1, 7], changes in the hepatobiliary system lead to disruption of the carbohydrate, antitoxic, and synthesizing functions of the liver, and a decrease in the exocrine function of the pancreas is noted: the activity of trypsin and lipase in patients is increased, and the activity of amylase is decreased. Increased lipase activity promotes accelerated absorption of fat in the intestine.

The central nervous system affects the trophism of organs and tissues in which lipogenesis and lipolysis processes occur. The appearance of striae and marbling is the main manifestation of hypothalamic dysfunction. The ventrolateral and ventromedial nuclei of the hypothalamus affect eating behavior. This explains the increase in appetite. Manifestations of hypothalamic dysfunction are thirst, headache, autonomic disorders, and intracranial hypertension. In addition to the leading changes, in 60% of cases, children had accelerated physical development (high growth), corresponding to the 90–95 percentile of the standard deviation for a given age and gender, and 25% had growth >+ 2SDS.

According to literary data, in children with obesity, examination reveals a decrease in phagocytosis, lysozyme activity, and complement in the blood [2, 3]. Pathology of the respiratory system is pathogenetically associated with a high position of the diaphragm, limited mobility due to fat deposition in the abdominal cavity, increased intra-abdominal pressure, fatty infiltration of the respiratory muscles, and impaired hemodynamics in the chest cavity. Reduced

ventilation of the upper respiratory tract and lungs contributes to the development of congestive bronchitis and pathology of the ENT organs. The tendency to allergic diseases is due to an increase in the level of circulating immune complexes in obese children. In children and adolescents with obesity, changes in the nervous system, higher nervous activity and behavior (38%) were revealed: obsessive-compulsive neurosis, low stress resistance, respiratory neurosis, accentuated character traits of the emotionally labile type, hyperdynamic behavioral disorders, emotional disorders of adolescence, subfebrile temperature, logoneurosis, impaired thermoregulation, motor tics, enuresis, anxious-suspicious character traits (16%), tension headaches (22%).

## CONCLUSION

1. In children with obesity, the leading complications and concomitant diseases are gastropathology (96%) with predominant damage to the hepatobiliary system and pancreas, cardiac disorders - 50%, metabolic disorders (47%), accelerated or accelerated physical development (85%).

2. The obtained results allow us to say that the examined group of children with obesity is at risk of developing cholelithiasis, statohepatitis, liver fibrosis and cirrhosis, hypertension, early atherosclerosis and coronary heart disease, type 2 diabetes mellitus, dysmetabolic nephropathy, and reproductive dysfunction.

3. Metabolic syndrome was almost 1.5 times more common in children with grades 1–2 obesity (with a BMI from +1 to +2) than in children with grade 3 obesity.

4. The group of children with primary metabolic syndrome has a high percentage of relatives with type 2 diabetes mellitus; these are children with grades 1–2 obesity; metabolic signs appear before the age of 10. This suggests genetically determined insulin resistance; in the group of patients - patients with obesity of the 3-4th degree, in this case the history of obesity is more than 5 years, the age is approaching adolescence, simple obesity is often found in relatives of this group, in this case, metabolic syndrome should be regarded as secondary against the background of "obesity with history", this confirms the presence of metabolic syndrome in 100% of cases in children with obesity of the 4th degree.

5. From this follows the tactics of examination and treatment: all children over 10 years old (metformin is contraindicated under 10 years and obesity under 10 years is rare, in 20% of cases) regardless of the degree of obesity it is necessary to conduct an oral glucose tolerance test (OGTT), examine blood for lipidogram, the level of uric acid in the blood and daily urine, microalbuminuria 2-3 times a year, conduct daily monitoring of blood pressure 1-2 times a year in order to identify metabolic syndrome; when identifying violations characteristic of metabolic syndrome, examine the level of glycated hemoglobin. Frequent association with the components of metabolic syndrome, such diseases as non-alcoholic fatty liver disease, cholelithiasis, myocardial dystrophy against the background of dyslipidemia and arterial hypertension, hyperandrogenism syndrome (polycystic ovary syndrome) are introduced into the examination program for children with obesity ultrasound of the abdominal cavity, ECG, echocardiography 1-2 times a year. Children with secondary metabolic syndrome over 12 years old should begin treatment with orlistat (Xenical), in children with primary metabolic syndrome over 10 years old, there is a need to collectively consider the issue of prescribing biguanide (metformin). This is due to the fact that, according to clinical guidelines, metformin is allowed in pediatric practice only with an established diagnosis of type 2 diabetes mellitus. High incidence of obese children reflects reduced immunological reactivity of the body. Therefore, it is necessary to sanitize chronic foci of infection using physiotherapeutic methods of influence, hardening measures.

All children with obesity need psychological help, since changes in the functional state of the central nervous system become pathogenetic factors of obesity.

Thus, one of the tasks of modern medicine is to combat the rapidly growing epidemic of type 2 diabetes and the associated increased risk of cardiovascular diseases. And this fight should begin in childhood, namely, with the prevention of excess weight and obesity. And this "fight" against obesity and prevention of its complications should be carried out by a team of specialists - pediatricians, endocrinologists, nutritionists, neurologists, psychologists, ophthalmologists, gastroenterologists, cardiologists, allergists, immunologists, physiotherapists with the involvement of specialists from sanatoriums, preschool institutions, schools, teachers. The solution to the complex problem of obesity depends on the coordinated work of this team, not without the participation of parents and the patient himself.

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