МАТЕМАТИЧЕСКИЕ МЕТОДЫ И ИНФОРМАЦИОННЫЕ ТЕХНОЛОГИИ В МЕДИЦИНЕ

INTEGRAL HEALTH INDEX

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Abstract. The main purpose of this study was to research basic clinical and hormonal, metabolic and psychological disturbances in children with obesity in various periods of the year. To estimate the effectiveness of occupational therapy and identify the features of different systems of the body depending on the periods of the year on the basis of the calculation value of the integral indicator of health for children with obesity.

The survey included 298 children (200 with obesity and 98 healthy children, month-to-month differences in the lipid and hormonal status of healthy children in the Siberian region were established and clinical and laboratory characteristics of childhood obesity within a year were described. From December to July, in contrast to other months of the year, violations of psychoemotional status and decline in physical performance, improving lipid profile and proinflammatory cytokines were identified. Differentiated approach to the treatment of children with obesity, taking into account the monthly features of the main indicators of clinical, hormonal, metabolic and psychological status of these patients was substantiated.

Keywords: children, obesity, periods of the year, treatment, overall health, scaling, Pareto chart, a function of Harrington.

Introduction. Currently, there is an increased interest in the study of rhythmic processes in the body, both in normal conditions and in pathology. The study of biorhythms allows to assess the level of reactivity, functional state and adaptive capabilities of the organism [1, 2, 3]. To this end, a large number of studies in the field of chronobiology of energy balance of the organism were made [4, 5], and the influence of seasonal changes in the environment on the functional state of organs and systems [4, 5], the level of physical performance, as the adaptive capacity and resistance of the organism, the effectiveness of medical, health [6, 7] and training [7, 8] activities were examined. Despite this, the choice of a clear therapeutic approach, given the time period of the year in children with obesity in pediatric practice to date does not exist. Monthly study of metabolism indexes in healthy children and children with obesity may serve as a basis for the development of new approaches and methods of rehabilitation of pediatric patients with obesity and increase the effectiveness of therapy in the adverse timing of the annual cycle. For an objective assessment of the effectiveness of treatment of a large number of recorded parameters for each patient, one must select the most informative indexes, providing the greatest contribution to treatment outcomes. The development of an individual integrated indicator of the health of children with obesity were proposed.

Research methods. In accordance with the intended purpose, a research strategy was developed. It included a monthly study of lipid and hormonal status in healthy children and obese children during the year and evaluation of the effectiveness of the standard complex of restorative treatment.

Patients. In accordance with the goal and objectives the clinical study of 298 children was conducted. They included 200 patients (100 boys and 100 girls), which were obese of I-III degrees aged 10 to 15 years (of 12.9±1.5 years) and 98 children of a similar age (12.8±0,1 years) were almost healthy (40 boys and 58 girls). They constituted the control group. 7–19 people were surveyed monthly. The inclusion criteria were children age from 10 to 15 years, the consent of the child, the parents signing a voluntary informed consent, body weight ≥ 95 percentile. The condition of children was assessed at admission of children to treatment and at the end of the rehabilitation course. Indexes measured in children were clinical and laboratory data: indexes of the immune system, biochemical and hormonal blood tests.

The control group included children of average physical development, blood pressure parameters not exceeding 90 percentile for a given sex and age, without chronic diseases, in which there were no acute diseases within 3 months before the study.

All patients with obesity (200) were prescribed standard treatment. The complex consisted of a reduced-calorie diet, doing step aerobics on a daily basis, Sharko shower every other day (10 sessions), electro sleep every other day (10 sessions), sessions with a psychologist.

The diagnosis of obesity was established according to the accepted classification [3]. Centile tables of weight, height, waist circumference [9] were used to evaluate physical development. Indexes of waist circumference (WC) corresponding 90 or more percentile were evaluated as abdominal obesity. The body weight was evaluated using percentile tables of weight and body weight index (BWI) for the certain age and sex [9, 10, 11]. Blood pressure indexes were assessed by centile tables taking into account gender, age, height.

Assessment of immediate results of treatment was conducted according to a special adapted integrated modular system, health assessment, which is based on a unified system of standardization of the values of quantitative and qualitative indicators on a scale of Harrington [4, 5, 6] and the integral-modular assessment of health with the determination of an integral index of health (IIH) [6]. When evaluating the effectiveness of treatment indexes that affect the patient's quality of life and indexes describing the development of metabolic disorders were used: complaints (level of appetite, fatigue, shortness of breath on exertion, headaches, discomfort associated with excess weight); objective measures (BWI, blood pressure, indicators of functional state of the cardiovascular system (according to VEM); indicators of hormonal-metabolic status (fasting glucose, cholesterol level, HDL-C, TG, insulin); indicators of emotional state (level of stress, situational anxiety, emotional tension).

It is required to solve the following problems:

- to select informative indexes of the total number of registered, determine equilibrium values and tolerances;
- to choose the method of scaling of a source data to bring them to a single dimensionless measurement system for the subsequent merger of the integral index of health;
- to develop a method to evaluate the effectiveness of treatment on the basis of an integrated index of health.

Pareto chart was used to select informative indexes. It is simple enough to grasp by doctors and does not require sophisticated software solutions on the one hand, on the other hand, it provides speed and accuracy of calculations.

It is necessary to combine variables of different scale, when calculating the integral index of health (IIH). To make a valid comparison of values of different laboratory features scaling is usually used. Main issues of the scaling of the input information are, first, the choice of a suitable scale, secondly, the choice of the membership function [5–9].

In this paper we used the membership function of Harrington.

After scaling and aligning the baseline to the interval [0-1], the function of Harrington takes the form:

$$E = \sqrt{\frac{(d_1 - 1)^2 + (d_2 - 1)^2 + ... + (d_n - 1)^2}{n}} = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(d_i - 1)^2} \qquad (1)$$

where d_i is the value of initial indexes x_i, that normalized to the interval [0-1]; n – number of indexes.

When calculating Euclidean distance, it is defined how far the patient under study is from the healthy man with ranging varieties equal to 1.

The integral index is easy to represent in percentage for medical workers. To do this it is necessary to subtract value E, calculated with the formula (1), for a certain patient from 1 in order to get the result in the form of the current value of the health level and not as the deviation from the norm:

$$IIH = (1 - E) * 100\% \qquad (2)$$

In order to make a conclusion on the health condition of a patient, the integral of values of IIH from 0 to 100% one can divide so-called health levels according to the Harrington scale (table 1).

Table 1. The scale of correspondence of the integral index to the health level

IIH, %	**Health level**
100...80	Normal
80...63	A slight decrease
63...37	A moderate decrease
37...20	A significant decrease
20...0	Marked decrease

The method of individual assessment of the state of human health on the basis of clinical and functional parameters does not only provide the ability to make unbiased decisions, but also allows their application in the evaluation of the effectiveness of sanatorium-resort treatment. It is necessary to determine the IIH before and after treatment. Besides, the introduction of the integral index allows to predict the effect of an assigned treatment.

The results of the study and their discussion. 200 children with obesity were examined. The age of patients at the beginning of the disease was 6.5±2.2 years. The disease duration was 4.5±2.3 years (6 months to 10 years). Obese children had a family history of obesity – 100 (50% children), thyroid diseases – 10% (20 patients), diabetes mellitus type 2 – 11% (22 children), hypertension – 23% (46 people).

Anthropometric indexes showed that all the children under observation had a hypersthenic constitution with highly developed subcutaneous fat. Excess body weight in children with obesity before treatment was 45.04 (22.10; 58.67)%, BMI was % to 28.91 (of 27.21; 30.17) kg/m^2. WC was consistent with abdominal type of obesity in 42 (21%), which is a risk factor for metabolic disorders in these children.

For children with obesity it was characteristic to have tension of the psychoemotional sphere. Increase of levels of common stress (CS), situational anxiety (SA) and mental and emotional stress (MES during all months of the year, in comparison with healthy children ($p<0.05$). Decline of physical performance and endurance was noted in children with obesity. Decline of tolerance to physical stress (according to VEM) was registered from December to July (average of 75.5 W), relative to healthy (92.1 (up 86.8; 97.4) W), $p<0.05$.

Most of the researchers note mandatory for obesity changes in lipid metabolism [3, 7]. Monthly study of lipid metabolism in healthy and obese children has revealed mixed trends in these indicators. Thus, the content of AL in blood serum from September to December and March was higher in healthy children ($p<0.05$), and in January, February, April and December – obese children, $p<0.05$ (table. 1). The cholesterol level of healthy children was characterized by an increase from September through January relative to other months, $p<0.05$. In patients with obesity cholesterol indexes exceeded the indexes of healthy people in February, spring (March, April, may) and summer months (June, July), $p<0.05$. In September, minimum values of total cholesterol were recorded in children with obesity, in healthy people – maximum values, which is probably connected with different reaction at the beginning of the school year in healthy and obese children.

The increase of cholesterol level in children with obesity was observed in February, March and June relatively to other months of the year, $p<0.05$ (table. 1). Healthy children from September to October were noted with maximum content of HDL, compared to other months of the year. The decline of HDL in children with obesity, relatively healthy, was recorded in January, may, June, September, and October, $p<0.05$. In February the lowest level of HDL-C was recorded in children with obesity of 1.09 (0.89; of 1.22) mmol/l and in October – the highest of 1.29 (1.06; of 1.65) mmol/l, $p<0.05$. Maximum values of TG in the blood serum of healthy children was in summer months (June-August), $p<0.05$.

It is known that elevated levels of TG in childhood as predictors of early development of cardiovascular disease in adults [3, 7]. In children with obesity the content of TG was higher than in the healthy group, $p<0.05$ from February to May.

The content of insulin in the blood serum of obese children in almost all months of the year was significantly higher than in healthy children, but the maximum values were recorded in December as 20.6 (11.5;25.2) and March of 15.7 (11.1 V;21,7), $p<0.05$ in comparison with indicators of November 11.0 (7,8;14.3). The content of cortisol in blood serum in children with obesity in December, January, February, March, June, and July exceeded the same in the spring (April, May) and autumn (October and November) months, $p<0.05$ (table.2).

Thus, in healthy children during the autumn-winter the intensification of lipid metabolism was noted, it can be considered as an adaptive reaction to cold time of year, when the use of lipid energy in order to compensate for increased energy costs. We believe that the change in the lipid spectrum in children with obesity (relatively healthy) throughout the year can be regarded as the initial stage of the formation of lipid disorders.

On the basis of a monthly analysis of indicators of clinical and metabolic status in children with obesity, we hypothesized that the efficacy of standard integrated physio-balneotherapy in the time intervals of the year from December to April, from May to July and from August to November will be different.

3 time periods were marked in the result of search for the largest deviations of the studied indexes by months in children with obesity: from December to April, from May to July, and from August to November.

After treatment, the condition of obese children in all groups improved, frequency of complaints reduced. All children tolerated treatment satisfactorily. After treatment the standard complex had a decrease in body weight, WC, HC at all time periods of the year. Decline in physical performance (according to veloergometry) was observed from December to April and from May to July – before and after treatment, $p<0.05$. The increase in exercise capacity was observed during treatment only from August to November, and 81.0 (78.3 per; 90.0) to 87.5 (85.0; 100.0) W, $p<0.05$. The increase in «total work» was reported only in intervals from August to November and from May to July, $p<0.05$.

The results of the study of mental and emotional status after application of complex treatment showed that in all time periods of the year the OS level of emotional stress (MES) reduced, $p<0.05$. The increase in «total work» was reported only in intervals from August to November and from May to July, $p<0.05$. However, the level of OS in children with obesity after treatment from August to November decreased by 12% and amounted to 6.0 (1.0; 9.0) scores. The level of ST in children treated from August to November, decreased by 24% and amounted to 37.0 (30.0; 42.0) scores, it did not differ from that of healthy children. Level of MES also decreased by 24%, $p<0.05$. Thus, children who were receiving treatment from August to November, improvement of emotional state was more pronounced, compared with patients who were treated in other time intervals.

After applying a standard set of treatment decrease of levels of TL and cholesterol was reported only from August to November. Change of TL made -0.10 (-1.10; to 0.20) mmol/l and TC -0.20 (-0.72; 0.43) mmol/L. From December to April, an increase of TC in the blood of obese children was reported after a complex treatment from 4.03 (3.25; 4.82) to 4.66 (3.77; 5.55) mmol/l, $p<0.05$, and from May to July, the impact of the medical complex did not lead to the change of initially increased cholesterol level in the blood of obese children. The tendency for decrease in TG in obese children after treatment were observed only from May to July with 0.78 (0.62; 0.97) to 0.72 (0.54; to 1.09) mmol/l, and in the period from December to April, the TG level after treatment was higher than the indexes of healthy children in the same time period of the year and was 0.94 (0.72 to; to 1.31) mmol/l, $p<0.05$. Changes in HDL-C after treatment was not observed in any of the periods of the year (tab.1).

An important role of insulin resistance and leptin resistance is observed in the pathogenesis of obesity and related diabetes and the metabolic syndrome [1, 3, 10, 11]. Insulin level in patients during the year did not differ between the groups and decreased after treatment ($p<0.05$), but it was higher than the con-

trol values. Increased content of leptin treatment decreased in all groups ($p<0.05$). Cortisol in all children did not go beyond the limit of control indexes both before and after treatment, which suggests that the assigned therapeutic complexes did not cause disorders of adaptive reactions of the organism [12–15].

Conclusions. Thus, high efficiency of standard treatment (including diet therapy, exercise therapy, Sharko shower, elektroantriebe and psychotherapy) obese children is observed from August to November (increase of integrated health indicator by 15.4%). In other months of the year a correction of assigned complexes with regard to the obtained results is required.

The analysis of the contribution of individual indexes to change the value of the integral indexes of health was conducted. The result of the selection of informative indexes was that the number of analyzed laboratory data was cut in half, it significantly reduced the cost of examination of patients.

A generalized health index for the 3 groups of obese children was calculated, it allowed to assess the effectiveness of rehabilitation. When using a comprehensive assessment of the health status of children with obesity before and after treatment a pronounced positive effect only in the time interval from August to November was observed (increase of IIH 15.4%). The effectiveness of the standard complex treatment of obese children from December to July was 1.6 a 1.7 times lower. From December to April, the impact of the standard complex was insufficient for the correction of disorders in the psychoemotional sphere (indexes of OS and ST), physical performance (indexes of exercise capacity and general work) and lipid metabolism (cholesterol and TG), which was reflected in a moderate increase of IIH (9.8 per cent) after treatment. From May to July. IIH increased only by 9.2% after treatment due to the absence of pronounced dynamics of indexes of psycho-emotional sphere (OS and ST) and physical performance.

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МЕДИЦИНСКАЯ ДИАГНОСТИЧЕСКАЯ СИСТЕМА ПОДДЕРЖКИ С ИСПОЛЬЗОВАНИЕМ АЛГОРИТМОВ МАШИННОГО ОБУЧЕНИЯ

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MEDICAL DIAGNOSTIC SUPPORT SYSTEM BY USING MACHINE LEARNING ALGORITHMS ON ANDROID PLATFORM

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Abstract. The modern world provides new and innovative ways to improve the delivery of medical care and diagnostics. Currently, there are technologies related to medicine in two key areas: treatment and diagnosis. The treatment eliminates various types of diseases. Diagnostics allows citizens to learn more about their health.

The health care segment is right in the middle of a rapid technological development cyclone, and it is difficult to assess which technologies will have far-reaching consequences.

With the growing number of patients, human-like robots may be able to provide basic care, for example, acting as companions for sick or elderly people.

In the healthcare industry, machine learning is a fast-growing trend due to the advent of devices and sensors that can use data to assess a patient's health status in real time. This technology can also help medical experts analyze data to identify trends that may lead to improved diagnoses and treatment.

Keywords: machine learning, data mining, artificial intelligence, android, mobile application.