SOMATIC STATUS AND PHYSICAL DEVELOPMENT OF CHILDREN WITH IDIOPATHIC SCOLIOSIS

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Abstract. Relevance. *Scoliotic disease is a genetically determined pathology of the human musculoskeletal system, which is characterized by a multi–plane deformation of the spine and chest, complicated by disorders of the functions of organs and systems, and it reduces the quality of life of the children and leads to their disability*

The objective. *To assess physical development and somatic status of children with idiopathic scoliosis.*

Materials and methods of research. *We examined 128 children and adolescents aged from 3 to 17 years old with IS. The average age was 10.2±0.39 years old. Of all the examined children with grade I deformity was found in 31.3% (40/128), with grade II in 23.4% (30/128), with grade III deformity 17.2% (22/128 children), and with grade IV 28.1% (36/128). Among the children prevailing one was thoracic type of scoliosis (35.2%; 45/128), followed by thoracolumbar type of localization (27.3%; 35/128), combined one (23.4%; 30/128), and finally lumbar type of localization (14.1%; 18/128). Anthropometric indicators were body height, body weight and BMI. BMI was calculated using the following formula: body weight (kg) / height (m2). For a comparative assessment of the indicators of height, body weight and BMI to the age of children, depending on gender and age, Z-scores were calculated according to the methodology proposed by WHO (2007), with an assessment of its clinical significance [7].*

To analyze the dynamics of volumetric and velocity parameters of the FVD and FVC of children with IC, we conducted spirographic studies using MAS2-S spirometry. At the same time, the following indicators were determined: the forced vital capacity of the lungs (FVC), the volume of forced exhalation (FEV), the air flow velocity at the time of exhalation of a certain proportion of the FVC (MOS, more often 25, 50, 75% of the FVC).

The results of the study and conclusions. *Using anthropometric data of children and adolescents with idiopathic scoliosis decrease in growth rates was proved in 33.3%, in connection with which protein-energy malnutrition of moderate and mild degree develops (25.7%). When studying the somatic status in children and adolescents with I and II stages of deformation, it was found that changes from the somatic systems are functional in 32.6%, whereas in children and adolescents with III-IV stages of IS 85.2% had not only structural changes in the spine, but also increase in somatic disorders inp the systems of the child's body.*

Keywords: *children, somatic status, physical development, idiopathic scoliosis*

Relevance. Scoliotic disease is a genetically determined pathology of the human musculoskeletal system, [3, 4, 11], which is characterized by a multi–plane deformation of the spine and chest [8, 9, 13], complicated by disorders of the functions of organs and systems [5, 6, 17], and it reduces the quality of life of the children and leads to their disability [1, 16].

The prevalence of idiopathic scoliosis (IS) in the adolescent population of 14-18 years old, according to various data, is 2-3% [10], while deformities with an arc size of more than 30° account for 0.2% and about 0.1% are deformations of 40° or more [10] when the need for surgical treatment of scoliosis is considered [12]. According to various data, all clinically significant forms of scoliotic deformities reaching the surgical stage of the disease can account for 0.1% - 0.38% of all scoliosis cases [2].

In the Republic of Uzbekistan, the prevalence of scoliosis by region ranges from 1-1.5% of the total population [15] or 219,334 – 329,000 people in absolute terms. If we take into account the fact that progressive forms of scoliosis requiring active surgical treatment, according to world statistics, amount to 0.1% -0.38%, then in absolute terms 21933 – 125020 residents of the republic of different ages will need surgical treatment, of which children and adolescents under 18 years of age make up 40%, or 13160 – 50008 people [14].

In the structure of scoliotic pathology IS is the most common and it potentially invalidates patients starting from childhood and adolescence. Based on three different age peaks of its occurrence, three following groups were identified: infantile IS detected at the age of 3 years old; juvenile IS in the range from 5 to 10 years old and the most common one, with about 80% of all cases; and adolescent IS detected from 10 to 18 years old [13, 18].

The occurrence of scoliosis in childhood and adolescence affects the development of the body. The progression of the course of this pathology causes innervation of internal organs, due to which the child's body becomes susceptible to various diseases. The clinical course of scoliosis has a direct adverse effect on the function of the cardiovascular and respiratory systems; it contributes to the reduction of physiological disorders that lead to an imbalance of the adaptive capabilities of the child's body. In their turn, weakness of back muscles and abdomen, constant bent position lead to disorders of intestinal peristalsis and biliary function. In children and adolescents suffering from scoliosis there is a slowdown in physical development. In connection with the above, the study of the somatic and physical health of children and adolescents with scoliosis is an urgent task, as it will contribute to the optimization of effective ways of prevention and treatment of this pathology.

The objective: to assess physical development and somatic status of children with idiopathic scoliosis.

Materials and methods of the study: We examined 128 children and adolescents aged from 3 to 17 years old with IS. The average age was 10.2±0.39 years old. Of all the examined children with grade I deformity was found in 31.3% (40/128), with grade II in 23.4% (30/128), with grade III deformity 17.2% (22/128 children), and with grade IV 28.1% (36/128). Among the children prevailing one was thoracic type of scoliosis (35.2%; 45/128), followed by thoracolumbar type of localization (27.3%; 35/128), combined one (23.4%; 30/128), and finally lumbar type of localization (14.1%; 18/128).

To assess the growth and development of children using growth curves according to WHO standards, a monitoring questionnaire was developed and approved by the Order of the Ministry of Health of the Republic of Uzbekistan No. 145 dated March 30, 2007. Anthropometric indicators were body height, body weight and BMI. BMI was calculated using the following formula: body weight (kg) / height (m2). For a comparative assessment of the indicators of height, body weight and BMI to the age of children, depending on gender and age, Z-scores were calculated according to the methodology proposed by WHO (2007), with an assessment of its clinical significance [7].

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The results of the study were statistically processed using standard methods of variational statistics using the Student's t-test, according to Excel-Office-2019. The average values are presented as M ± m (mean ± mean average error). The differences in the mean values were considered significant at a significance level of $P<0.05$.

The results of the study: Anthropometric measurements and analysis of the average statistical level of development of 128 children with IP in a comparative aspect with WHO standards showed that the level of physical development of both girls and boys in most cases (35.5% and 42.3%) corresponded to the indicators corresponding to the median.

5.8% of boys with IS had low body weight (-) 2 CO - (-) 3 CO (CO- standard deviation); among girls this indicator was 11.8%, which was significant ($P<0.05$). The percentage of boys who were within (-) 1 CO - (-) 2 CO was 1.9%, and for girls it was 9.2% ($P<0.05$). Most of the girls with IS (56.6%) were within the range of indicators (-) 1 CO – 0, that is, below standard deviations, and there were 15.4% of boys within the same range. In 40.4% of the boys with IS body weight indicators corresponded to WHO standards, while among girls this percentage was 22.4%, which is almost 2 times lower ($P<0.05$). Signs of overweight were observed in 36.5% of boys with Isi in the range of 0 - (+) 1 CO. The girls were not overweight.

Growth indicators also had their own fundamental features in children with IS, both boys and girls, when compared with WHO standards. Thus, in 28.8% of boys with IS height corresponded to the median data, while in girls this percentage was 21.1%. The majority of children with IS had deviations in height indicators in the direction of stunting, and girls had low height indicators more often (73.6%) than boys (63.5%).

To date, according to WHO, an increasing problem in the growth and development of children is overweight and obesity. However, children with IS have protein-energy malnutrition (PEM) of varying degrees. In 5.8% of boys and 3.9% of girls with IS BMI indicators fall in the area (-) 2 CO - (-) 3 CO, which is regarded as moderate grade PEM; in 21.2% and 25%, respectively, in the area (-) 1 CO - (-) 2 CO with risk of mild PEM. In other cases BMI indicators are in the range of -1CO to +1CO, which corresponds to normal indicators.

We also found that, with an increase in the degree of scoliosis, children began to lag behind in body length, so with the III and IV degrees of IS, this indicator was at the level of -2CO and -3CO (31.3 and 24%, respectively) (Table 1).

According to the average body weight, the examined children and adolescents with IS in most cases were in the range of -1CO to +1CO, which corresponds to normal indicators. However, there is still a tendency for indicators to decrease depending on the degree of scoliosis. So if at grade I 7.5% of body mass indicators were in the region of (-) 2 CO - (-) 3 CO, whereas at grade III in 18.2% ($P<0.05$). There was an unevenness of body weight, increasing together with height with the progression of IS and an increase in the angle of curvature.

Thus, in children and adolescents with IS there is a decrease in body weight, stunting and the development of moderate and mild PEM. The increase in the magnitude of curvature of the spine in IS in children is accompanied by disorders in organs and systems. A change in the location of internal organs in IS almost always causes functional, and then, organic disorders of internal organs.

Table 1

Percentage of examined children with IS according to the correspondence of body weight, height, and BMI to standard deviations dependently on the stage of scoliosis

	Stage of scoliosis							
	I stage of scoliosis (n=40)		II stage of scoliosis (n=30)		III stage of scoliosis (n=22)		IV stage of scoliosis (n=36)	
	n	%	n	%	n	%	n	%
Body mass (kg)								
(-) 2 CO - (-) 3 CO	3	7.5	4	13.3*	4	18.2*	2	5.6
(-) 1 CO - (-) 2 CO	4	10	8	26.7*	0	0.0	3	8.3
(-) 1 CO - 0	14	35	10	33.3	10	45.5	16	44.4
Median	12	30	6	20.0	5	22.7	11	30.6
0 - (+) 1 CO	7	17.5	2	6.7*	3	13.6	4	11.1
Height (cm)								
(-) 2 CO - (-) 3 CO	3	7.5	4	13.3*	7	31.8*	9	25.0*
(-) 1 CO - (-) 2 CO	5	12.5	4	13.3	6	27.3*	7	19.4
(-) 1 CO - 0	16	40	0	0.0	8	36.4	3	8.3*
Median	13	32.5	17	56.7	1	4.5*	16	44.4
0 - (+) 1 CO	3	7.5	5	16.7*			1	2.8
BMI								
(-) 2 CO - (-) 3 CO	5	12.5	9	30.0	4	18.2	7	19.4
(-) 1 CO - (-) 2 CO	9	22.5	9	30.0	7	31.8	12	33.3
(-) 1 CO - 0	6	15	10	33.3	7	31.8	14	38.9
Median	17	42.5	2	6.7	2	9.1	3	8.3
0 - (+) 1 CO	2	5	0	0	2	9.1	0	0
(+) 1 CO - (+) 2 CO	1	2.5	0	0	0	0	0	0

Note: * - reliability of the data to the values of the 1st group ($P<0.05$)

The mechanics of the act of breathing is disrupted due to deformation of the chest, changes in the trophic intercostal muscles and diaphragm, and lung ventilation pathology. The heart in the deformed chest forcibly increases the average pressure in the pulmonary artery, there is an overload of the right heart and the appearance of a kyphoscoliotic heart. Later cardiopulmonary insufficiency occurs, the quality of life decreases and disability develops.

Until now, the patterns of occurrence of organic functional disorders, the influence of the degree of deformation and age criteria, the dynamics of changes in internal organs after surgical treatment, and measures to prevent organic pathology of the cardiorespiratory system have not been practically studied.

Analyzing the dynamics of the volumetric and velocity parameters of the FEV decrease in the VCL was found with increase in the severity of deformation (Table 2).

Table 2

Original parameters of the external breathing function among the examined children with IS

Stage of scoliosis	FVC	FEV1	MOC25	MOC50	MOC75
I (n=40)	85.1±2.2*	83.1±2.5*	78.3±2.1*	76.5±1.9*	81.9±3.2*
II(n=30)	83.3±1.9*	81.2±2.2*	75.7±1.9	71.3±2.2*	72.8±2.4*
III(n=22)	80.3±3.2	79.1±2.5	73.8±1.6	69.8±3.1	65.6±2.4
IV(n=36)	72.1±2.4	71.9±3.1	69.5±2.3	64.6±2.9	53.8±3.2

Note: * - reliability of the values in relation to the parameters of the patients with IS IV stage ($P<0.05$)

For the I, II and III degrees of IS in children the average value of VCL was 85.1%, 83.3% and 80.3%, respectively (normal indicators with functional deviations up to 20%), VCL more than 85% in I, II and III stages of IS we did not meet in any case. The indicators of FEV1 and MOS fluctuated within normal limits and there were no violations of FVC.

At the IV stage average VCL, FEV1 and MOS significantly decrease in relation to the I stage of IS ($P<0.05$). Generalized restrictive disorders of bronchial patency and hemodynamic changes were found in this group of children. However, there were no complaints relevant to bronchopulmonary system (shortness of breath, difficulty of breathing).

On ECG, regardless of IS stage, 85.2% (109/128) had bradycardia with sinus arrhythmia (69.9%), 28.9% had supraventricular migration of the rhythm driver, in 90.6% of the cases (116/128) the vertical axis of the heart was recorded. Incomplete blockages of the right leg of the His bundle were noted in 50.0% of the cases, and myocardial disorders were recorded in 31.2% of the cases.

There were no changes in the neurological status in the I, II stages of IS, however, minor mild autonomic disorders were recorded in the II stage. According to the results of the study, myelopathic syndrome associated with the presence of chronic microcirculation disorders of the spinal cord, as well as muscle-tonic, pain and radicular syndromes were observed in children and adolescents with III and IV IS stages.

We have identified 9 factors that predetermined the structure of factor influence on the development of disorders in physical development and somatic status in children with IS (Table 3).

Table 3

The model of factor influence of IS on physical and somatic development of children

Factor	Name	E
F-1	*Female*	13.2
F-2	*Hereditary deformation of spinal cord*	8.5
F-3	*Age at the moment of deformation detection above 10*	14.7
F-4	Small body weight at birth (below 3000gr)	9.8
F-5	First child in the family	6.5
F-6	*Combination of other skeletal deformations*	10.2
F-7	*Flat feet*	5.8
F-8	*Thoracic cage deformation*	4.8

F-9	*Pelvic distortion*	3.7
F-0	Zero factor	4.2

The identified common factors by 95.8% (completeness of factorization) determined the nature of the causal influence, while all insignificant and unidentifiable factors in this model were combined (reduced) into the so-called "zero" factor (F-0: 4.2%).

The most significant factor in the development of disorders of the physical and somatic status of children with IS is the age at the moment of detection of deformity above 10 (r= 0.698), followed by female sex (r= 0.725), subsequent factors are low birth weight (below 3000, gr.; r= 0.525); burdened heredity by deformity spine (r=0.535), the first child in the family (r=0.495), flat feet (r=0.465), chest deformity (r=0.455) and pelvic distortion (r=0.385).

Thus, factor analysis revealed the most significant risk factors for physical and somatic status disorders in patients with scoliosis and predicted its outcomes.

Conclusions:

1. Using anthropometric data of children and adolescents with idiopathic scoliosis decrease in growth rates was proved in 33.3%, in connection with which protein-energy malnutrition of moderate and mild degree develops (25.7%).

2. When studying the somatic status in children and adolescents with I and II stages of deformation, it was found that changes from the somatic systems are functional in 32.6%, whereas in children and adolescents with III-IV stages of IS 85.2% had not only structural changes in the spine, but also increase in somatic disorders in the systems of the child's body.

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