Features of the physical development of children with bronchopulmonary dysplasia

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Summary: We observed 131 children (269 cases) with a diagnosis of bronchopulmonary dysplasia. Found that children with bronchopulmonary dysplasia characterized by a delay in weight gain (73.9 + 2.8%, p <0.0001), height (54.8 +3.2%, p <0.001) and body mass index (67.5 3.03%, p <0.001). Proven tendency to "catch up" with the average correction of 28 months of age in girls and 16 months - in boys. In 36 months, the body weight in 50% of women and 25% of the surveyed male reached the average. Dynamics of growth in children with bronchopulmonary dysplasia delayed up to 15 months corrected age in girls and up to 24 months - for boys. At 24 months of age corrected 50% female patients, showed a growth of more standard median. Male patients a growth rate standards only 36 months. Found a moderate correlation gain in body weight with respiratory failure II level (r = -0,442, p <0.05) and significant - with symptoms of respiratory failure III degree (r = -0,676, p <0.05). The dynamics of growth was significantly less correlated with signs of respiratory distress II and III degree (r = -0,146; r = -0,447, p <0.05). In analyzing the data in children with BPD revealed the dependence of low body weight (less than 25 percentile) (r = 0,429; p <0.05) and length (r = -0,149, p <0.05) on the presence of defects of the central nervous system disorders nervous and respiratory drive. Defined much dependence dynamics of body weight on the presence of episodes of hypoxia and disorders of the nervous and respiratory drive (p <0.05).

Introduction: patients with bronchopulmonary dysplasia (BPD) is a specific group of patients concerning as regards physical development. At one point the majority of patients with BPD are severely immature infants with a rather retarding development during the first year of life. At the other point the patients with BPD suffer from respiratory failure, hypoxia and pathologies of other systems, namely central nervous system, which can inhibit physical development of a child.

Comprehensive research performed by the scientists of Pediatrics department of Case Western Reserve University, USA gave evidence that body weight and mass indices decreased during the 8^{th} year of life in patients with BPD. In women these data reached the average rate between the 8^{th} and 20^{th} years of life. Body mass index in men remained to be reduced till 20 years [2]. And on the contrary, the research, carried out by the scientists of National State Institute of Pulmonology at Saint Petersburg Pavlov State Medical University, showed that children with bronchopulmonary dysplasia have a developmental delay only till the 2^{nd} year of life with a further normal growth of physical development indices [3]. Supposedly, physical

development of children with this disease depends on the region. It is also possible that the trend of the recent years towards milder forms of this disease which proceed with moderate hypoxia exerts some impact.

Thus, until now the issue of physical development of children with bronchopulmonary dysplasia has remained under debate. Physical development indices which best of all correlate with bronchopulmonary dysplasia, terms of mass and growth retardation, central nervous system impact degree and correlation of respiratory failure degree with physical development delay still remain unclear.

The objectives of the study: improvement of physical development diagnostic methods in children with bronchopulmonary dysplasia by determination of body mass and growth indices at different age periods and studying the impact exerted on these indices by hypoxia and central nervous system abnormalities with neuro-respiratory drive disorders.

Materials and methods: the study was carried out at the department of Pediatrics №1 and Neonatology of Kharkiv National Medical University (head of the department G. S. Senatorova) in the Regional Centre of Diagnostic and Treatment of Bronchopulmonary Dysplasia in Children of Kharkiv Regional Children Hospital (head doctor G. P. Muratov).

The study involved observation of 131 children (269 examinations) with diagnosed bronchopulmonary dysplasia (main group) and 26 children (42 examinations) who were born prematurely with respiratory disorders but did not develop bronchopulmonary dysplasia (comparison group). Bronchopulmonary dysplasia was diagnosed according to international classification of diseases, 10^{th} version (code P27.0).

Physical development was assessed in children at the age from 1 to 36 months of life. The research involved examination of children who were born at different gestation terms. In order to improve representativeness the adjusted age was calculated by formula:

$$\mathbf{A\ (a) = -40 + (A(g) + A\ (p)) / 4\ .}$$

Where **A (a)** is adjusted age in months, **A(g)** is gestational age of a child in weeks, **A (p)** is passport age in weeks.

All the examined patients have been measured to determine length/height and body mass. Body mass index (BMI) was also measured by the formula where body mass index is divided into square height (kg/m^2).

The indices were assessed by centile method in female and male patients separately. The indices were compared with the standards recommended in the decree №149 issued by the Ministry of Health of Ukraine "On clinical protocol of medical supervision of healthy children under 3 years of age", issued 20.02.2008 [5].

Respiratory failure degree in the examined children was determined by respiratory failure indices in early age children, recommended by the Protocol of rendering medical aid to children in specialty "Children Pulmonology" №18, issued on 13.01.2005 [6]. First-degree respiratory failure was determined in presence of dyspnea, tachycardia on physical exertion (for infants physical exertion is breastfeeding, screaming, anxiety). Second-degree respiratory failure was determined in the presence of dyspnea, tachycardia at rest, moderate cyanosis of lips and acrocyanosis. Nasal flaring, intercostal space retraction in breathing. Third-degree respiratory failure was determined in the presence of tachypnea, dyspnea up to 80-100 inspirations per minute at rest, general cyanosis of skin and mucosa. Involvement of auxiliary muscles in breathing.

Presence of central nervous system (CNS) abnormalities along with neuro-respiratory drive disorders was confirmed by a neurologist.

Correlation of indices with the presence of respiratory failure and central nervous system abnormality with neuromuscular conductivity was analyzed by Spearman method (r_s).

Results of the research and their discussion.

The children of the main group were born at the age of 30±0,32 weeks, the children of the comparison group were born at the age of 32,5±0,47 weeks of gestation. The difference between the groups is not statistically reliable ($p>0,05$) which proves the comparability of the groups and excludes the impact of more severe prematurity in one of the cohort on the physical development of a child.

In groups of children who were born prematurely, had respiratory disorders but did not develop bronchopulmonary dysplasia, 34,1±7,4% of children had insufficient body mass as to their age, 23,8±6,6% of the examined children had a growth delay as to their age, IMT lower than average was in 35,7±7,48% children. Statistically reliable larger number of children with bronchopulmonary disorder had a delay in body mass increase (73,9±2,8%; $p<0,0001$), height increase (54,8±3,2%; $p<0,001$) and body mass index (67,5±3,03%; $p<0,001$).

Centile analysis showed that the body mass in the majority of girls was less than median standard (fig.1). The trend to "catch up" the average indices was detected only during the 28th month of life. By the third year of life the body mass median in female patients with BPD became equal with average body mass indices, suggested by WHO.

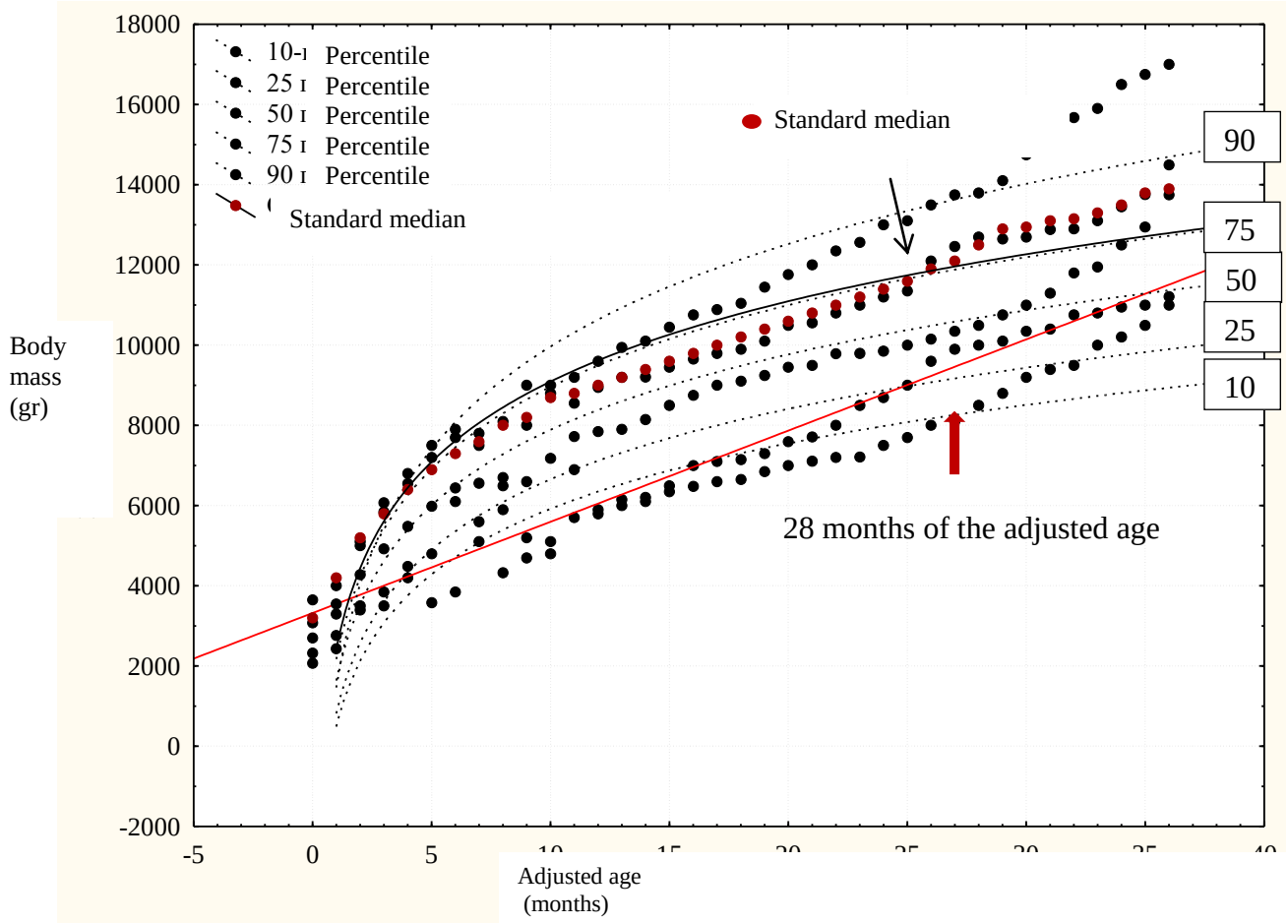

Fig.1 Percentile diagram of mass as to age in girls with bronchopulmonary dysplasia (n=126).

Body mass in all the boys in the main group did not reach median indices till 16 months of life (fig.2). There was observed a moderate trend to "catch up" body mass from the 16th month of adjusted age and the boys showed a quicker body mass growth from the 30th months of life. Despite this trend, body mass in 75% of boys was less than average standard indices at the 36th month of adjusted age.

We have analyzed the impact of respiratory failure and central nervous system abnormalities with neuro-respiratory drive disorders on the dynamics of body mass indices in children with BPD. Approximately half of children (54±3,4%) had first-degree respiratory failure. First-degree respiratory failure did not affect body mass growth ($r=0,129$; $p>0,05$). Central nervous system abnormalities with neuro-respiratory drive disorders were not detected in this category of patients. The data which we have received are indicative of a high probability that other factors influence body mass growth in patients with BPD, which requires further investigation.

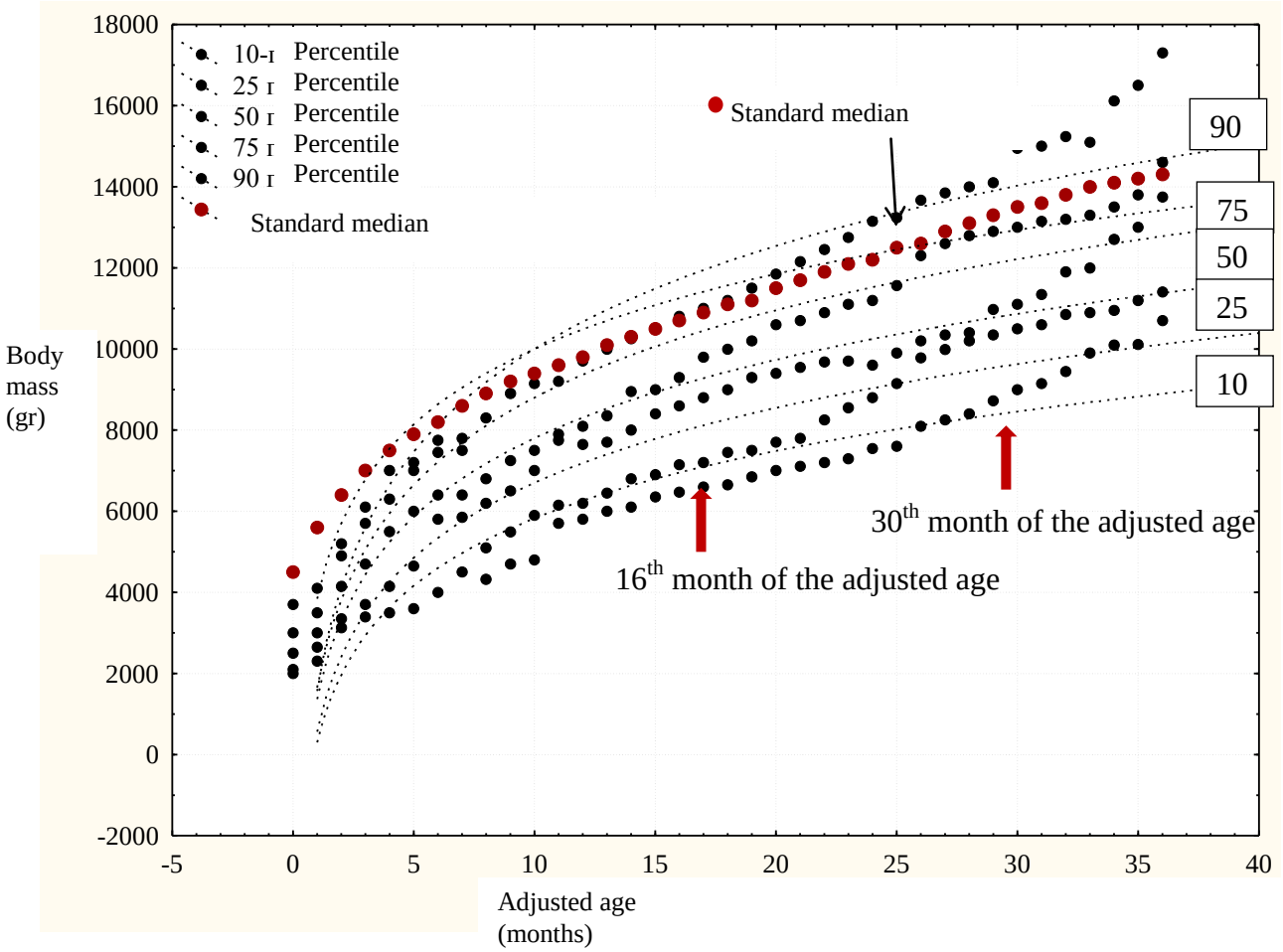

Fig.2 Percentile diagram of mass as to age in boys with bronchopulmonary dysplasia (n=143).

We have determined a moderate correlation of body mass growth with second-degree respiratory failure ($r=-0,442$; $p<0,05$) and a significant correlation with symptoms of third-degree respiratory failure ($r=-0,676$; $p<0,05$). It is necessary to mention that children with second and third-degree respiratory failure underwent artificial lung ventilation or additional oxygen administration to support $SatO_2$ more than 92%. On equal terms with this, insufficient body mass growth can be considered to be the marker of hypoxia attacks which requires its timely detection and correction. The main group children were found to have dependence of low body mass (less than 25 percentile) on the presence of central nervous system abnormality with neuro-respiratory drive disorders ($r=0,429$; $p<0,05$). The data show that there is a necessity to analyze the state of central nervous system in patients with BPD with low body mass indices.

The girls with bronchopulmonary dysplasia were found to have a delay in body length growth till the 15th month of the adjusted age (fig.3).

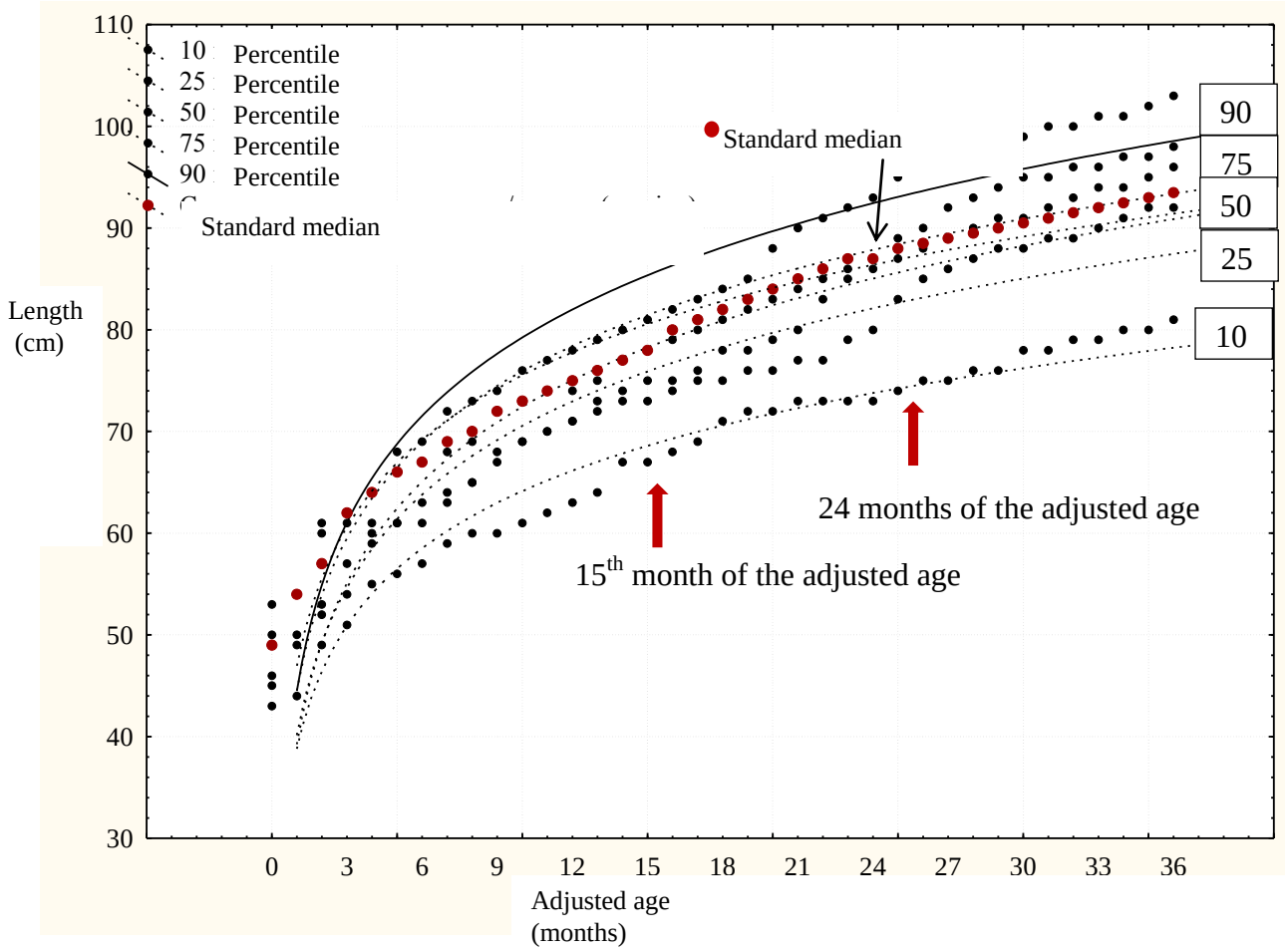

Fig.3 Percentile diagram of length/height as to the age in girls with bronchopulmonary dysplasia (n=126).

From 1 year 3 months the dynamics of height increase began to accelerate in girls. From 2 years the growth median in female patients with BPD corresponded to average height indices in girls, recommended by WHO.

In boys with bronchopulmonary dysplasia height increase acceleration began only from the 24th month of the adjusted age and reached average indices only at the age of 3 years (fig.4).

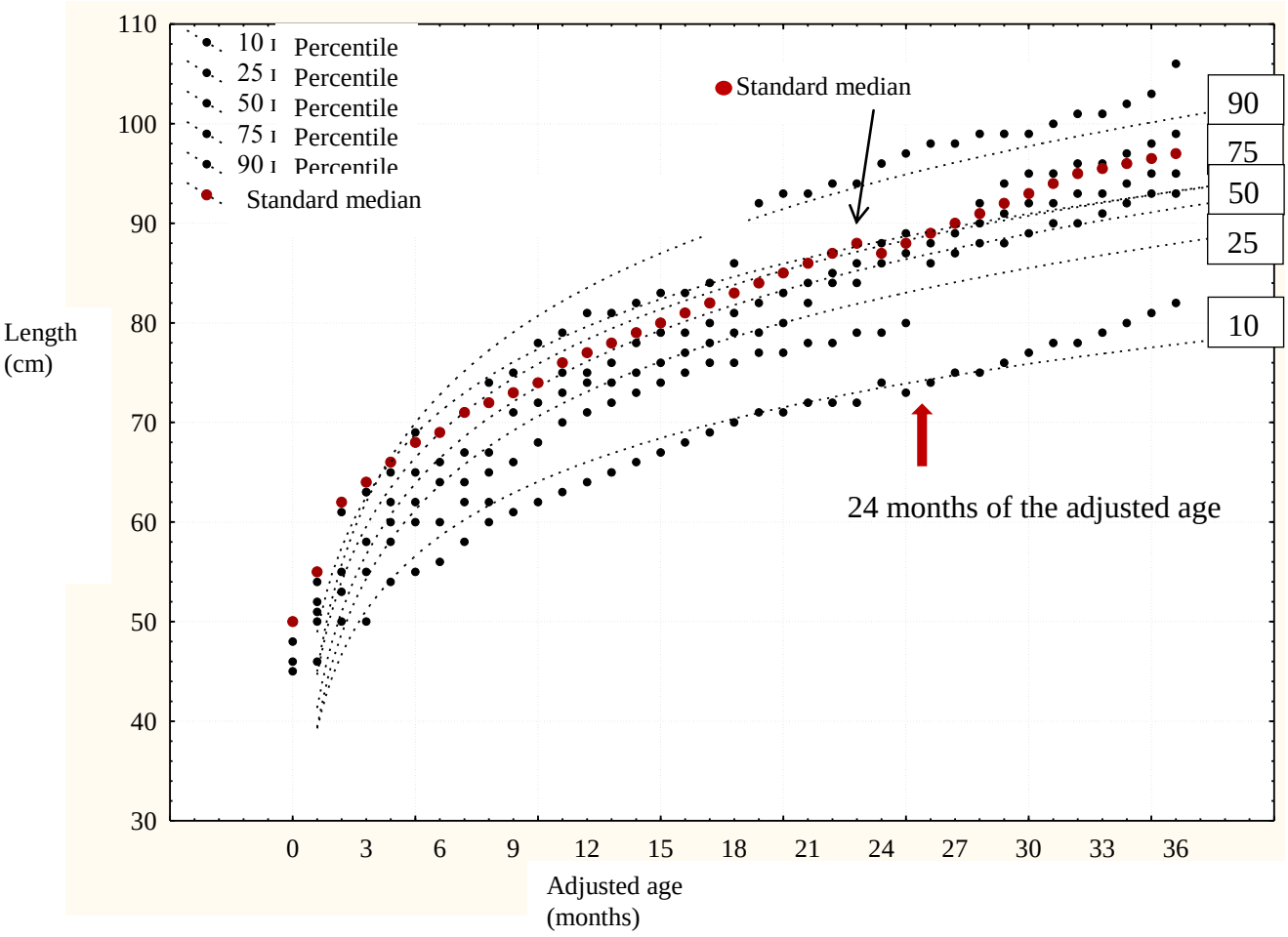

Fig.4 Percentile diagram of length/height as to age in boys with bronchopulmonary dysplasia (n=143).

Thus, height increase dynamics in children with bronchopulmonary dysplasia reflects its delay till the 15-24th month of life with a significant acceleration of height increase till the 3rd year of life.

First-degree respiratory failure did not affect height increase dynamics in patients with bronchopulmonary dysplasia ($r=0,138$; $p>0,05$). Second-degree respiratory failure showed a minimum dependence on the height increase ($r=-0,146$; $p<0,05$) and third-degree respiratory failure signs correlated moderately with third-degree respiratory failure symptoms ($r=-0,447$; $p<0,05$).

Central nervous system abnormalities in patients with BPD with neuro-respiratory drive disorders showed a minimum correlation with insufficient body length increase ($r=-0,149$; $p<0,05$). The data are indicative of a more significant sensitivity of body mass dynamics to hypoxia attacks and neuro-respiratory drive disorders ($p<0,05$), which is necessary to consider when determining BPD severity criteria.

Conclusion:

1. A delay in body mass increase (73,9±2,8%; p<0,0001), height increase (54,8±3,2%; p<0,001) and body mass index (67,5±3,03%; p<0,001) is typical for children with bronchopulmonary dysplasia.
2. 50% of female patients were found to reach standard body mass indices at the 36th month of the adjusted age and standard height indices at the 24th month. Among male patients only 25% of the examined children reached average body mass indices and 50% of children reached standard median height indices by the 36th month of the adjusted age.
3. Children with bronchopulmonary dysplasia were found to have moderate correlation of body mass increase with second-degree respiratory failure (r=-0,442; p<0,05) and significant correlation with third-degree respiratory failure symptoms (r=-0,676; p<0,05). Height increase dynamics significantly less correlated with second and third-degree respiratory failure signs (r=-0,146; r=-0,447; p<0,05).
4. More significant sensitivity of body mass dynamics to hypoxia attacks and neuro-respiratory drive disorders has been determined (p<0,05).

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