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Features of Physical and Motor Development of Children with Congenital Heart Defects

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Abstract: Congenital heart defects (CHD) occupy a leading position in the structure of child mortality and remain one of the most common causes of perinatal mortality. CHDs represent a public health problem not only in Uzbekistan, but throughout the world. This article presents the results of a literature review of scientific research works devoted to the problem of congenital heart defects, published in domestic and foreign literature.

Children with congenital heart defects (CHD) are characterized by developmental features that are based on pathology of the cardiovascular system. The type and severity of congenital heart disease, the age of correction of the defect and a number of other factors have a direct impact on the severity of its non-cardiac complications, such as disorders of physical and motor development, caused by the special conditions of the formation of the nervous system in conditions of congenital heart disease.

Keywords: congenital heart disease (CHD), classification, motor development; physical development; gross motor skills; fine motor skills; equilibrium; muscle strength; rehabilitation.

Congenital heart defects (CHD) are found in approximately 9 out of 1000 newborns, which is 1.35 million annually worldwide [1], and about a quarter of them require surgical treatment in the first months of life [2]. Given the increased survival of children with CHD compared to the last century and the majority of them reaching adulthood, the correction of non-cardiological complications of CHD, which include motor development disorders, is becoming increasingly important.

According to WHO, 4-6% of children are born with congenital malformations (CM) every year, with a mortality rate of 30-40% [3,4,5,6,7,8].

The incidence of congenital heart defects (CHD) currently accounts for more than 30% of all malformations [9].

Children have a natural need for physical activity. A child's motor activity contributes to his overall development at an early age and his formation as a full-fledged member of society at an older age. Children with congenital heart disease are characterized by developmental delays, the severity of which depends on the initial severity of the defect and the presence of genetic diseases, which are detected in 30% of children with congenital heart disease [10]. In addition, patients with congenital heart disease belong to the category of increased risk of brain damage due to the peculiarities of intrauterine development, postnatal exposure to hypoxia and intraoperative factors (for example, artificial circulation (AC)), which entails deviations in neuromotor development. Features of hemodynamics and metabolism, medication intake, hypoxemia and a number of other factors due to the presence of congenital heart disease also affect the physical development of children. This concept combines the process of growth,

weight gain, development of the muscular system and other organ systems, which, in turn, depend on the maturity and functional capabilities of the nervous system.

The objective is to systematize the currently available data on the characteristics of physical and motor development of children with congenital heart defects, on the factors underlying them, to substantiate the importance of a more in-depth examination of children at all stages of their development and the need to correct the identified disorders from the moment of their diagnosis. Since the physical and motor development of children are closely related to each other, with the development of the nervous and the state of the muscular systems, and muscle strength and balance are integral components of some motor skills [4], a separate section of the article is devoted to each of these parameters.

Physical development of children with CHD. According to the literature, patients with congenital heart defects are characterized by growth retardation and body weight retardation, which is associated with malnutrition [11,12]. Growth retardation in children with CHD is associated with tissue hypoxia, increased metabolism, impaired absorption of nutrients, low concentrations of insulin-like growth factor-1, reduced cardiac output, pulmonary hypertension, repeated respiratory infections, intake of certain medications, and genetic characteristics [11]. It is believed that growth disturbances in infants with acyanotic heart defects are directly proportional to the severity of hemodynamic disturbances, and the presence of cyanosis in heart disease in children aggravates the severity of malnutrition: according to statistics, with “pale” defects the child’s weight gain is more impaired, while with In blue congenital heart disease, children are more likely to experience retardation in height and body weight [11]. Another important factor is nutrition. Mothers of children with CHD often complain of feeding problems due to poor appetite or refusal of food by the child [13]. It should be noted that feeding difficulties in a child with CHD may be not only a sign of heart failure, but also of concomitant neurological pathology [14], which may be a consequence and/or aggravated by tissue hypoxia in conditions of impaired hemodynamics. One of the first publications on this problem were J. Benn's data on the height and body weight of school-age children with patent ductus arteriosus: the body weight of boys and girls, according to statistics, was lower than that of their peers, and at the same time, girls were statistically significantly higher than their peers [15]. M. Campbell, et al. analyzed the data of 200 patients (0–35 years; 88.5% — children 0–14 years) with various CHDs, about half of whom had tetralogy of Fallot. Scientists have found that the more pronounced the cyanosis, the more the CHD affects the patient's growth: the average growth in the group of acyanotic defects was 98% of normal values, while in the group of severe "blue" defects - 94%. Scientists have proven that the presence of CHD has a greater impact on the body weight of patients. Thus, the average body weight in the studied cohort corresponded to 85% of the average normal. Moreover, the severity of cyanosis turned out to be inversely proportional to body weight: this indicator for "pale" and severe "blue" defects was equal to 91% and 77% of the average normal body weight, respectively. It was also found that as patients grow older, body weight increasingly begins to depend on age and less on height. It is noteworthy that in patients with tetralogy of Fallot, deviations from the norm in both height (97.1% versus 94.5%) and body weight (87.2% versus 78.3%) were significantly less pronounced than in other cyanotic congenital heart defects, in connection with which the authors concluded that not only cyanosis influences the developmental delays of children with congenital heart defects [16].

Motor development. The work of the body muscles ensures voluntary motor activity. Motor development predetermines the accuracy and speed of motor activity, and, consequently, the achievement of its goal. Motor skills are a set of coordinated human actions aimed at performing precise movements. Delay in motor development is considered one of the main developmental problems in children [11]. Motor disorders can have a negative impact on various areas of a child's life: performing everyday activities (e.g., dressing, eating), participating in games with other children, school activities, sports, the child's self-esteem and his position in the society of peers. All this can subsequently lead to a sedentary lifestyle and aggravate health problems [10]. Scientists have begun to pay more attention to the development of motor skills in children with

congenital heart defects in the last two decades, although as early as 1949 M. Campbell, et al. drew attention to the delay in learning to walk in this cohort of patients [16].

It is currently known that delayed motor development is typical for 30–60% of children with congenital heart disease [15, 17] in approximately equal proportions at different age periods [17]. According to statistics, impaired motor skills in children with congenital heart disease are detected from an early age. According to long-term studies, delays in the development of gross motor skills in this category of children are detected as early as 2 months of age [18]. S. Fourdain, et al. published data showing that 79% of infants with congenital heart disease at the age of 4 months had delays in motor development and required rehabilitation treatment [18]. In the absence of correction of motor disorders in infancy, especially in the presence of severe congenital heart disease in a child, the problem persists in early childhood. The results of the analysis of data from 294 children with CHD showed that only 52% of them learned to walk by the age of 18 months, and 73% by 2 years, in connection with which the researchers concluded that the time of onset of walking is directly affected by cyanosis/decreased blood oxygen saturation and poor muscle mass development. Thus, in the group with "pale" defects, 76% and 92% of children learned to walk by 1.5 and 2 years, while in the cohort of "blue" defects - only 47% and 69%, respectively [16]. According to the latest data, late onset of walking is a predictor of disorders even in healthy preschool children in such motor development indicators as fine motor skills and balance [19]. Their perceptual and motor experience determines the physical and motor development of children, and also affects their emotional, psychosocial and cognitive development. Therefore, our aim was to evaluate the motor development of children with congenital heart defects compared with their healthy peers. We compared 194 children with a mean age of 10.0 years and a standard deviation of 2.7 years, representing the full spectrum of congenital heart defects, with a control group of 455 healthy children with a mean age of 9.6 years and a standard deviation of 2.17 years. The Pediatric Body Coordination Test was used to test motor development. Of the children with congenital heart defects, 26.8% had moderate and 31.9% had severe motor impairment, compared with 16.5% and 5.5% in the control group, with p values of less than 0.001 for these differences. The mean motor quotient adjusted for age and sex was lower in children with congenital heart defects than in their healthy peers: 79.6 with a standard deviation of 18.9 versus 96.6 with a standard deviation of 15, a difference with a p-value of less than 0.001. Depending on the presence and/or degree of residual sequelae, children with congenital heart defects were divided into two subgroups: with no or mild residual sequelae or with significant sequelae. The mean motor quotient was lower in patients with significant residual sequelae: 75 years with a standard deviation of 19.3 versus 83 with a standard deviation of 17.9, a difference with a p-value of less than 0.01. In both subgroups, the mean motor quotient was lower, with a p-value of less than 0.01, than in the control group. Our results show that children with congenital heart defects have motor developmental impairments that are found in the absence or mild sequelae as well as in the presence of significant residual sequelae. Parental overprotection may contribute to these findings [21].

A review of scientific publications has shown that the problem of disorders in the physical and motor development of children with congenital heart disease is relevant today. While motor disorders are detected in 6-10% of children in the average population [4], and approximately 5-6% of children suffer from dyspraxia [29], a cohort of children with congenital heart disease is characterized by a more pronounced and frequent delay in motor development. Each child is individual, but it is obvious that children with congenital heart disease have many more predisposing factors for the development of neuromotor disorders than their healthy peers. Such factors include the following:

- preoperative (intrauterine circulatory disorder [3], structural anomalies of the brain [4], acidosis [29], duration of hypoxemia [28], extracardiac concomitant pathology);
- surgical (duration of CB [4, 20, 28,29],
- intraoperative seizures [3], repeated surgeries [27]);

- postoperative (hyperlactatemia in the first 5 days after surgery [29], acute cerebrovascular accident [3], seizures [8, 20], low cardiac output [4], limited physical activity [18], length of stay in the intensive care unit [20], duration 29] and frequency of hospitalizations [29], muscle hypo- or hypertonia [8], the need for extracorporeal membrane oxygenation, installation of an artificial ventricle);

Conclusion:

The conducted analysis of the literature showed that children with congenital heart defects are characterized by features of physical and motor development that have a significant impact on the child's life and which must be taken into account during examination and rehabilitation of this category of patients. The development of motor function contributes to the independence and self-sufficiency of the child, and, consequently, to an improvement in the quality of his life. Therefore, at present, there is an extremely urgent need to examine not only the cardiovascular system, but also the physical development and motor sphere of children with congenital heart defects, as well as the development of methods for their timely correction.

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