Received: 28 February 2025 / Accepted: 02 June 2025 / Published online: 30 June 2025

DOI 10.34689/SH.2024.27.3.026

UDC 616-007-053.1:612.171.7-053.4

COGNITIVE COMPONENT IN THE REHABILITATION OF PRESCHOOL CHILDREN WITH CONGENITAL HEART DEFECTS. LITERATURE REVIEW.

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Abstract

Introduction: Advancements in prenatal diagnostics, cardiac surgery, and intensive care have markedly increased the survival rates among children with complex congenital heart defects (CHD). Recent neuropsychological studies have convincingly demonstrated that children with CHD are at high risk of developing cognitive impairments.

Aım: to analyze the literature data on the role of the cognitive component in the rehabilitation of preschoolers with congenital heart defects.

Search strategy: as part of the preparation of the literature review, a multi-stage strategy for searching for scientific information was implemented using the following databases and platforms: PubMed, Google Scholar and UpToDate. Based on the results of the search, 71 scientific publications were selected that are most relevant to the purpose and subject of the study with a search time interval spanning the last 10 years.

Results: The cognitive functioning of a child is one of the most vulnerable areas in the presence of congenital heart disease, which affects not only due to the pathology itself, but also due to mandatory cardiac surgery. Despite the growing attention to this problem, the prevalence of cognitive impairment in children and adolescents with congenital heart abnormalities is still underestimated and insufficiently reflected in clinical practice.

Disorders of neurodevelopment in CHD are caused by a complex interaction of factors acting at various stages, starting from the antenatal period and ending with postoperative recovery. Predictors of cognitive impairment include both organic (including chronic hypoxia and cerebral hypoperfusion) and iatrogenic effects (for example, artificial blood circulation, anesthesia, and postoperative complications).

Conclusions: In a number of countries, there are no structured monitoring and support programs for children with CHD after surgical treatment, routine assessment of cognitive and psycho-emotional development is not carried out, and there are not enough specialists who know the methods of neuropsychological diagnosis and correction.

Keywords: *cognitive impairment, congenital heart defects, preschoolers.*

For citation:

Kapanova A.A., Alimbaeva A.R., Dairbekov Y.E., Abylgazinova A.Zh., Bektar Zh.S., Kovylina R.G., Masalov A.Ye., Terdykbayeva Z.S. cognitive component in the rehabilitation of preschool children with congenital heart defects. Literature review // *Nauka i Zdravookhranenie* [Science & Healthcare]. 2025. Vol.27 (3), pp. 245-254. *doi 10.34689/SH.2024.27.3.026*

Резюме

КОГНИТИВНЫЙ КОМПОНЕНТ В РЕАБИЛИТАЦИИ ДОШКОЛЬНИКОВ С ВРОЖДЕННЫМИ ПОРОКАМИ СЕРДЦА. ОБЗОР ЛИТЕРАТУРЫ.

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Введение: благодаря прогрессу в пренатальной диагностике, кардиохирургии и интенсивной терапии значительно повысилась выживаемость детей с тяжелыми формами ВПС. Нейропсихологические исследования последних лет убедительно демонстрируют, что дети с ВПС подвержены высокому риску развития нарушений когнитивного профиля.

Цель исследования: анализ литературных данных о роли когнитивного компонента в реабилитации дошкольников с врожденными пороками сердца.

Стратегия поиска: в рамках подготовки литературного обзора была реализована многоступенчатая стратегия поиска научной информации за последние 10 лет с использованием следующих баз данных и платформ: PubMed, Google Scholar и UpToDate. По итогам поиска отобрана 71 научная публикация, наиболее соответствующие цели и тематике исследования.

Результаты: Когнитивное развитие ребёнка представляет собой одну из наиболее чувствительных сфер при врождённом пороке сердца, на которую воздействует не только сама сердечная патология, но и необходимость хирургического вмешательства. Несмотря на возрастающий интерес к этой теме, уровень распространённости когнитивных нарушений у детей и подростков с врождёнными пороками сердца всё ещё остаётся недооценённым и не получает должного внимания в клинической практике.

Нарушения нейроразвития при ВПС обусловлены сложным взаимодействием факторов, действующих на различных этапах — начиная с антенатального периода и заканчивая послеоперационным восстановлением. К предикторам когнитивных нарушений относятся как органические (в том числе хроническая гипоксия и церебральная гипоперфузия), так и ятрогенные влияния (например, искусственное кровообращение, анестезия, послеоперационные осложнения).

Выводы: В ряде государств отсутствуют структурированные программы наблюдения и поддержки детей с ВПС после хирургического лечения, не проводится рутинная оценка когнитивного и психоэмоционального развития, не хватает специалистов, владеющих методами нейропсихологической диагностики и коррекции.

Ключевые слова: *когнитивные нарушения, врожденные пороки сердца, дошкольники.*

Для цитирования:

Қапанова А.А., Алимбаева А.Р., Даирбеков Е.Е., Абылгазинова А.Ж., Бектар Ж.С., Ковылина Р.Г., Масалов А.Е., Тердыкбаева З.С. Когнитивный компонент в реабилитации дошкольников с врожденными пороками сердца. Обзор литературы // Наука и Здравоохранение. 2025. Vol.27 (3), С. 245-254. *doi 10.34689/SH.2024.27.3.026*

Түйіндеме

ТУА БІТКЕН ЖҮРЕК АҚАУЛАРЫ БАР МЕКТЕП ЖАСЫНА ДЕЙІНГІ БАЛАЛАРДЫ ОҢАЛТУДЫҢ КОГНИТИВТІ КОМПОНЕНТІ. ӘДЕБИЕТКЕ ШОЛУ.

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Кіріспе: пренатальды диагностика, кардиохирургия және қарқынды терапиядағы прогресстің арқасында ауыр ДПС бар балалардың өмір сүру деңгейі айтарлықтай өсті. Соңғы жылдардағы нейропсихологиялық зерттеулер ДПС-мен ауыратын балалардың когнитивті бейіннің бұзылуының даму қаупі жоғары екенін көрсетеді.

Зерттеудің мақсаты: туа біткен жүрек ақаулары бар мектеп жасына дейінгі балаларды оңалтудағы когнитивті компоненттің рөлі туралы әдеби деректерді талдау.

Іздеу стратегиясы: әдеби шолуды дайындау аясында соңғы 10 жыл ішінде ғылыми ақпаратты іздеудің көп сатылы стратегиясы келесі мәліметтер базасы мен платформаларын қолдана отырып жүзеге асырылды: PubMed,

Google Scholar және UpToDate. Іздеу қорытындысы бойынша зерттеудің мақсаты мен тақырыбына неғұрлым сәйкес келетін 71 ғылыми жарияланым таңдалды.

Нәтижелер: баланың когнитивті қызметі туа біткен жүрек ақауы болған кезде ең осал салалардың бірі болып табылады, ол патологияның өзінен ғана емес, сонымен қатар міндетті кардиохирургиялық араласудан да әсер етеді. Бұл мәселеге көбірек назар аударылғанына қарамастан, туа біткен жүрек ақаулары бар балалар мен жасөспірімдерде когнитивті бұзылулардың таралуы әлі де бағаланбайды және клиникалық тәжірибеде толық көрінбейді. ДПС-дағы нейродамудың бұзылуы антенатальды кезеңнен бастап операциядан кейінгі қалпына келтіруге дейінгі әртүрлі кезеңдерде әсер ететін факторлардың күрделі өзара әрекеттесуіне байланысты. Когнитивті бұзылулардың болжаушыларына органикалық (соның ішінде созылмалы гипоксия және церебральды гипоперфузия) және ятрогендік әсерлер (мысалы, жүрек-өкпе айналымы, анестезия, операциядан кейінгі асқынулар) жатады.

Қорытындылар: бірқатар мемлекеттерде хирургиялық емдеуден кейін ДПС бар балаларды бақылау мен қолдаудың құрылымдық бағдарламалары жоқ, когнитивті және психоэмоционалды дамуды күнделікті бағалау жүргізілмейді, нейропсихологиялық диагностика мен түзету әдістерін меңгерген мамандар жетіспейді.

Түйінді сөздер: *когнитивті бұзылулар, туа біткен жүрек ақаулары, мектеп жасына дейінгі балалар.*

Дәйексөз үшін:

Қапанова А.А., Алимбаева А.Р., Даирбеков Е.Е., Абылгазинова А.Ж., Бектар Ж.С., Ковылина Р.Г., Масалов А.Е., Тердыкбаева З.С. Туа біткен жүрек ақаулары бар мектеп жасына дейінгі балаларды оңалтудың когнитивті компоненті. Әдебиетке шолу // Наука и Здравоохранение. 2025. Vol.27 (3), С. 245-254. *doi 10.34689/SH.2024.27.3.026*

Introduction:

Congenital heart defects remain one of the most common developmental abnormalities — according to the World Health Organization, 8 to 10 cases per 1,000 live births are registered annually. Advances in prenatal diagnostics, cardiac surgery, and intensive care have significantly improved the survival rate of children with severe congenital heart defects CHD [24, 25, 28]. However, an increase in the number of surviving patients is accompanied by an increase in the detection of long-term neurological and neurocognitive complications that manifest themselves in preschool age, a period critical for the formation of basic cognitive functions and social adaptation [6, 36, 44].

Recent neuropsychological studies strongly demonstrate that children with CHD are at high risk of developing cognitive impairments. Among them, the most frequently noted are a decrease in the speed of information processing, impaired attention, disorders of executive functions [43], speech, and motor deficits. These disorders are caused not only by the anatomical features of the defect itself and frequent cases of chronic hypoxia, but also by factors such as intrauterine developmental delay, the impact of cardiac surgery using artificial circulation, postoperative complications (including strokes, seizures), as well as social and emotional aspects, including family stress and long-term hospitalizations [59].

Of particular concern is that cognitive deficits may remain subclinical in infancy but increase significantly by preschool and primary school age, negatively affecting learning, socialization, and emotional development. In this regard, the need for early and comprehensive rehabilitation is being updated, including with an emphasis on the cognitive component [6, 35].

Cognitive rehabilitation in pediatrics is a complex of targeted actions to develop and restore intellectual functions, adaptive behavior, and learning skills [57]. In the context of CHD, this component requires a remarkably subtle and interdisciplinary approach that considers not only medical, psychological, pedagogical, and social aspects [7-9,27].

This literature review analyzes existing data on the neurocognitive consequences of congenital heart defects in preschool children and the role of the cognitive component in their rehabilitation.

Aim: to analyze the literature data on the role of the cognitive component in rehabilitating preschool children with congenital heart defects.

Search strategy:

As part of the literature review preparation, a multi-stage search strategy for scientific information was implemented using PubMed, Google Scholar, and UpToDate databases and platforms.

The PubMed system used an extended query with MeSH: "cognitive impairment" and "congenital heart defects," with a search time interval spanning the last 10 years. Filters by age category (Preschool Child: 2-5 years) and full-text access to content were activated.

Google Academy used keywords in Russian: "cognitive impairment," "preschool children."

Based on the search results, 71 scientific publications were selected that most correspond to the study's purpose and subject.

Inclusion criteria included full-text access, publications in English and Russian, and clear, statistically valid conclusions.

Exclusion criteria included conference abstracts, materials from non-specialized media, and subjective sources (for example, personal messages or interviews without a verified scientific base).

Results

Congenital heart defects in children. The overall picture.

Congenital heart defects (CHD) occur in approximately 1% of live births [3, 33, 60] and represent around 28% of all major congenital anomalies [61]. These defects are also significant contributors to early mortality [7]. Newborns diagnosed with CHD exhibit a higher prevalence of brain abnormalities compared to the general population [34, 44, 58]. CHD is generally characterized as a structural defect of the heart and/or major blood vessels present at birth [25].

Critical CHD refers specifically to those lesions that necessitate surgical or catheter-based intervention within the first year of life.

This includes both cyanotic and non-cyanotic lesions. Early detection, emergency stabilization, and transportation to an appropriate pediatric cardiology center are essential steps to ensure optimal outcomes for newborns with these lesions [62].

Prevalence of congenital heart defects

According to a large-scale meta-analysis conducted by *Yingjuan Liu and colleagues* [24], the prevalence of congenital heart defects (CHD) at birth between 1970 and 2017 has steadily increased. The peak was recorded in 2010-2017, when the rate reached 9.41 cases per 1000 live births [95% confidence interval (CI): 8.60-10.25], which is statistically significantly higher than in the previous 15 years (P = 0.031).

Analysis of the dynamics showed that the main increase is due to the rise in the diagnosability of mild CHD, particularly defects of the interventricular and atrial septa and the open ductus arteriosus. These forms together account for about 93.4% of the total increase due to improved postnatal screening methods and early detection of less pronounced anomalies.

At the same time, the frequency of severe anomalies, such as obstructive outflow defects from the left ventricle, including hypoplasia of the left heart, decreased. Their prevalence decreased from 0.689 per 1000 (95% CI: 0.607–0.776) in 1995-1999 to 0.475 per 1000 (95% CI: 0.392–0.565) in 2010-2017. This decline probably reflects advances in prenatal diagnosis and subsequent termination of pregnancy when fatal malformations are detected.

In addition, the authors note pronounced geographical differences: the lowest rates were found in Africa — 2,315 cases per 1000 live births (95% CI: 0.429–5,696), while the highest rates were found in Asia, where the frequency reached 9,342 per 1000 (95% CI: 8,072-10,704) [25].

Relationship between congenital heart defects and cognitive impairment

Cognitive development in children is particularly susceptible to disruption in the context of congenital heart disease (CHD), with negative influences arising both from the cardiac defect itself and from the necessity of early surgical intervention. Although awareness of this issue is increasing, cognitive impairments in children and adolescents with CHD continue to be underrecognized and inadequately integrated into standard clinical assessments.

Neurodevelopmental complications in CHD patients are driven by a multifactorial process that spans from the prenatal phase through the post-surgical period. Contributing factors include both physiological insults, such as prolonged hypoxia and reduced cerebral blood flow, and medical interventions, including cardiopulmonary bypass, exposure to anesthesia, and complications following surgery.

Despite these risks, many children who undergo early surgical repair for complex CHD maintain overall intellectual functioning (IQ) within the normal range.

However, the average scores tend to be lower than peers in the general population, as evidenced by cohort and longitudinal studies [63].

Among clinically significant congenital heart defects, a special place is occupied by left heart hypoplasia syndrome (LHS), a severe abnormal condition in which there is an underdevelopment of the structures of the left half of the heart, including the mitral and aortic valves, the ascending aorta, and the left ventricle. This morphological anomaly leads to the fact that left-sided structures cannot provide the systemic blood flow necessary for the delivery of oxygen to all organs and tissues [23].

In newborns with OHLOS, the functioning of the cardiovascular system is utterly impossible without emergency intervention. The standard treatment strategy includes staged palliation — a sequence of palliative operations that begin in the neonatal period. The Norwood procedure constitutes the initial stage of surgical palliation, designed to establish systemic circulation through the right ventricle. This is followed in early childhood by a bidirectional Cavo pulmonary anastomosis (commonly known as the Glenn procedure), which partially redirects venous return to the pulmonary arteries. The final stage, the Fontan procedure, completes the circulation pathway by fully separating systemic and pulmonary venous blood flow, allowing deoxygenated blood to flow passively into the pulmonary arteries without passing through a ventricle.

Thus, the right ventricle begins to perform the function of the main pump of the systemic circulation, compensating for the anatomical and functional insufficiency of the left heart [26, 56]. Although congenital heart defects (CHDs) represent the most prevalent type of congenital malformation - affecting approximately 1% of all live births - hypoplastic left heart syndrome (HLHS) is regarded as one of the most critical and prognostically unfavorable variants within this group. Its course is characterized by a pronounced anatomical failure of the left heart chambers. It requires immediate and gradual surgical intervention in the first days of life to ensure systemic circulation and patient survival [49, 50].

Prior to the development of modern surgical techniques, hypoplastic left heart syndrome (HLHS) was uniformly fatal. One of the most significant long-term complications in survivors of HLHS is impaired cognitive development and neurological functioning. HLHS, along with other forms of congenital heart disease (CHD), is strongly associated with an elevated risk of neurodevelopmental disorders [28, 45].

To date, several meta-analytical reviews have been published to study the cognitive status of children with left heart hypoplasia syndrome (LHS) in the age range from infancy to 12 years. An early meta-analysis examining cognitive outcomes in children and adolescents with different types of congenital heart disease (CHD) synthesized findings from four studies published prior to 2005. This review examined indicators of general intelligence (FSIQ), verbal intelligence (VIQ), and productive intelligence (PIQ). The results indicated a marked decrease in FSIQ and PIQ and an average decrease in VIQ in children with OHLOS. In contrast, in patients with other types of CHD, cognitive abnormalities were minimal or moderate, suggesting that SGLOS is associated with more pronounced long-term cognitive consequences compared to other forms of congenital heart disease.

Additional data are provided by *Sistino J.J., Bonilha H.S.* (2012), who conducted a secondary analysis of cognitive indicators as part of an extended quantitative review of survival and functional outcomes in preschool and primary school children with OHSS. This review includes 10 studies published before 2010. According to the results, preschool children showed reduced average values on the Bayley II scale of mental development, while the average general intelligence index (FSIQ) in children aged 6-12 years was in the lower limit of normal, which indicates persistent cognitive development disorders in this clinical population [40].

The results presented in the reviews of *Karsdorp P.A. et al.* (2007) [17] *and Sistino J.J., Bonilha H.S.* (2012) [40] emphasize the relevance of further study of neurocognitive functioning in children with left heart hypoplasia syndrome (LHS) and provide an essential empirical basis for further research in this area. However, both reviews have several methodological limitations to consider when interpreting the data obtained.

Thus, a meta-analysis by *Karsdorp P.A. et al.* [17]. It included only four studies available at the time of publication that analyzed cognitive performance in children with OHLOS at an average age of 2.8 to 9 years. Despite the significance of their findings, the limited number of samples and heterogeneity of data reduce the generalizability of the results. *Sistino J.J., Bonilha H.S. [40]* provided a generalized average FSIQ value for school-age children. Still, their work does not calculate standardized effect sizes for cognitive functioning in preschool and primary school age groups.

In addition, none of these reviews considered possible moderators of effects, such as age at the time of intervention, type of surgical treatment, presence of postoperative complications, or socio-economic status of the family, which limits the ability to analyze factors that affect the degree of cognitive deficits [17, 41].

Classification and Characteristics of Cognitive Impairment in Preschool Children with congenital heart defects.

Cognitive functions are an integrated complex of higher mental processes responsible for the perception, processing, and storage of information, as well as for the implementation of purposeful behavior. These functions traditionally include attention, memory, speech, thinking, perception, and executive functions, including planning, self-regulation, and activity control [38]. In children with congenital heart defects (CHD), the formation and implementation of these processes can be disrupted at different stages of ontogenesis, starting from the intrauterine period. Based on clinical, psychological, and neurophysiological studies, it is possible to identify the main areas of cognitive impairment characteristic of preschool children with CHD [29, 37].

Most second-year children with CHD experience mental retardation, particularly in speech and movement development [64]. One of the most frequent cognitive impairments in CHD is a lack of voluntary attention, decreased stability, and concentration [65]. These disorders manifest in increased distractibility, an inability to focus on a task, and frequent changes in activity. In more severe cases, symptoms similar to attention deficit hyperactivity disorder (ADHD) are recorded. Causes include hypoxic-ischemic damage to the frontal lobes and features of the maturation of prefrontal brain structures [63].

Preschool children with CHD may suffer from short-term and long-term memory problems, especially speech and visual-spatial memory. This difficulty makes it challenging to master new knowledge, complicates memorizing instructions, and impairs the formation of learning motivation [14]. According to neuropsychological studies, children with CHD often have impairments in verbal information encoding strategies, which indicates immaturity of the hippocampus and medial structures [10].

Delayed speech development in children with CHD can be associated with peripheral hearing and articulation disorders (for example, after prolonged mechanical ventilation) and central ones-impaired phonemic hearing, poor vocabulary, and difficulties constructing phrases. Expressive and receptive speech are affected, which in turn affects the formation of social skills [37, 38].

In children with CHD, executive functions (planning, self-regulation, working memory, flexibility of thinking) are underdeveloped. This manifests in difficulties moving from one task to another, impulsivity, and problems with behavioral control. Such features often prevent children from following rules and instructions, even if their intelligence is intact [66].

A significant proportion of children with CHD experience discoordination, difficulties in orientation in space, and violations of graph-motor skills. These features may be associated with the underdevelopment of the cerebellum, premotor, and parietal cortex. In practice, they manifest themselves in awkward movements, difficulties in writing and drawing, and violations of fine motor skills [5].

Neurocognitive deficits in children with CHD are often accompanied by emotional disorders such as anxiety, low self-esteem, and impaired adaptation in the team. These conditions, in turn, exacerbate cognitive symptoms, creating a vicious circle. Studies have shown that children with CHD experience more behavioral and emotional impairments compared to children in the general population [67][1].

Mechanisms of Cognitive Impairment in Children with congenital heart defects

Understanding the pathophysiological and neuropsychological mechanisms underlying cognitive disorders in congenital heart defects (CHD) is critical for developing effective rehabilitation strategies [18, 51]. Modern studies emphasize the multifactorial nature of these disorders, where organic, genetic, metabolic, hemodynamic, and socio-psychological factors all play significant roles [19, 22, 46].

The most significant mechanism is considered to be chronic and/or episodic hypoxia of the brain. In children with cyanotic CHD (e.g., Fallot's tetrad, transposition of the main vessels), there is a constant decrease in oxygen saturation in the blood, which leads to hypoxic damage to the cortex and subcortical structures. The hippocampus, frontal lobes, and cerebellum are particularly vulnerable, supporting memory, attention, and motor planning [2, 52].

Even children with non-cyanotic CHD may experience systemic impairment of cerebral perfusion due to defects in intracardiac hemodynamics (e.g., ventricular septal defect, aortic coarctation). Reduced cerebral blood flow, especially

during critical periods of neuronal development (the third trimester of pregnancy and the first two years of life), leads to decreased gray and white matter volume, which is confirmed by MRI studies [39, 68].

Surgical interventions, especially with the use of artificial blood circulation (IC), represent an independent risk factor for cognitive impairment. Micro embolism, hypoperfusion episodes, blood pressure fluctuations, and reperfusion injuries may occur during surgery. Neuroimaging shows that after IC, children have an increased risk of developing periventricular leukomalacia, hemorrhages, and post hypoxic changes [59, 69].

In 20-35% of children with CHD, genetic syndromes accompanied by cognitive disorders are detected: Down syndrome, Di Giorgi syndrome, Williams syndrome, and microdeletions 22q11. These conditions complicate the neuropsychological profile by impairing intelligence, learning ability, and speech skills. Even without syndromic pathology, polygenic mutations affecting cognitive development may be present [9, 70].

Prolonged hospital stays, forced isolation from peers, frequent medical interventions, lack of emotional contact with parents, fears, and pain create a stressful environment for the child. These factors negatively affect the formation of emotional regulation and socialization, indirectly impacting cognitive development and reducing adaptive potential [15, 32].

Families of children with CHD often face high levels of anxiety, overprotection, and emotional burnout [30]. Lack of proper stimulation at an early age, overloading with medical procedures, and lack of a stimulating environment all reduce the child's cognitive plasticity, slowing down the development of initiative and creativity. This issue is especially pronounced in preschool-aged children, for whom play and social interaction serve as the central drivers of cognitive and emotional development [8].

Modern Approaches to Cognitive Rehabilitation in Preschool Children with congenital heart defects

Effective cognitive rehabilitation for children with congenital heart defects (CHD) necessitates early intervention, a comprehensive framework, and a multidisciplinary approach to address the multifaceted nature of neurodevelopmental challenges [4]. Of particular importance is the individualization of programs that take into account the child's neurological, psychosocial, and somatic characteristics. When basic intellectual, behavioral, and communication skills are being developed in preschool, rehabilitation activities can significantly impact the long-term prognosis [11, 47, 53].

Modern cognitive rehabilitation for children with congenital heart defects (CHD) is guided by several core principles:

1. **Early initiation** - interventions should commence within the first months of life. In cases where CHD is diagnosed prenatally, preparatory work with the family can begin even before the child's birth to optimize developmental outcomes [12, 21, 48];
2. **Individual approach** - rehabilitation should be tailored to the severity of the cardiological condition, neuropsychological profile, family background, and speech status [21];
3. **Integration into everyday activities** - corrective tasks should be integrated into daily routines, games, and educational activities [36];
4. **Multidisciplinary approach** - participation of specialists from various fields: pediatric neurologists, neuropsychologists, speech therapists, physical therapists, pediatricians, cardiologists, and family psychologists [12, 36, 54].

Research supporting improved cognitive performance:

One of the notable directions in recent research focuses on children with transposition of the great arteries (TGA), a severe form of congenital heart defect.

According to observational and systematic reviews [31, 42], neurodevelopmental outcomes in these patients show a wide range of impairments even after successful surgical correction in the neonatal period. In particular:

Children assessed during the first five years of life often demonstrate delays in speech and motor development, as well as lower cognitive performance compared to the general population;

Early postoperative follow-up and multidisciplinary interventions are associated with improved cognitive scores and better behavioral adjustment outcomes during preschool years. Parents reported improved attention, memory, and stress tolerance [31] [42].

Intervention Programs with Proven Effectiveness: In international practice, the following types of programs have shown the most significant effectiveness:

1. **Neurodevelopmental Follow-Up Programs** (USA, Canada) — regular assessment of development and training of executive functions. Cognitive dysfunction levels decreased by 25-30% compared to the control group [13].
2. **The Parent–Child Interaction Therapy (PCIT)** model — active involvement of parents in therapy (play, behavior correction, cognitive stimulation) showed an improvement in the emotional background and a decrease in ADHD symptoms in children with CHD (*Valero-Aguayo* et al., 2021) [55].

According to a systematic review by *Koushiou M. et al. (2024)*, which included 48 studies (n=4,720 children), children with severe CHD had a reduction in cognitive scores of 8-15 points compared to population norms; cognitive training before the age of 6 showed a sustained effect for at least three years after the intervention. Programs that included family work and speech therapy were the most effective [20].

A scientific statement by the American Heart Association, along with a scoping review by Hofer et al., highlights that early individualized neuropsychological intervention combined with physical therapy may lead to improvements in cognitive outcomes in children with CHD. While specific gains vary, some studies report increases in IQ and executive function compared to children without intervention [16, 71].

Nevertheless, there is a clear consensus that cognitive rehabilitation must be an integral aspect of care for children with CHD, particularly during the first six years of life—a critical period marked by heightened neuroplasticity.

Conclusions:

Analysis of the current literature convincingly shows that cognitive impairment is a frequent and clinically significant consequence of congenital heart defects (CHD), especially in preschool children. These disorders significantly impact

the quality of life, learning, and social adaptation of the child, as well as the psych emotional state of their family.

Although most studies emphasize the importance of early cognitive correction, a systematic approach to organizing such assistance is not yet implemented in practice in all countries. In some countries, there are no structured programs for monitoring and supporting children with CHD after surgical treatment, no routine assessment of cognitive and psych emotional development, and a shortage of specialists trained in neuropsychological diagnosis and correction.

The authors took an active part in writing this article.

Kapanova A.A. Alimbaeva A.R. Kovylina R.A. Terdykbayeva Z.S. *- search for literary data and their processing.*

Kapanova A.A. Alimbaeva A.R. Dairbekov Y.E. Abylgazinova A.Zh., Bektar Zh.S., Masalov A.Ye. *- development of the literature review plan, editing the text and approving the final version of the article. The authors declare no conflict of interest.*

This literature review has not been submitted for consideration to other publications and has not been published in the public domain.

There was no financial assistance from outside.

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