



## A Cross-Sectional Study on the Association between Acyanotic Congenital Heart Disease and Cognitive Function in Children at Adam Malik Hospital Medan (2022–2023)

Aqilah Halwa Subrata<sup>\*1</sup>, Tina Christina Lumban Tobing<sup>2</sup>, Mustafa Mahmud Amin<sup>3</sup>, Dina Arwina Dalimunthe<sup>4</sup>

<sup>1</sup>Program Studi Pendidikan & Profesi Dokter, Fakultas Kedokteran, Universitas Sumatera Utara

<sup>2</sup>Departemen Ilmu Kesehatan Anak, Fakultas Kedokteran, Universitas Sumatera Utara

<sup>3</sup>Departemen Ilmu Kedokteran Jiwa, Fakultas Kedokteran, Universitas Sumatera Utara

<sup>4</sup>Departemen Ilmu Kesehatan Kulit dan Kelamin, Fakultas Kedokteran, Universitas Sumatera Utara

\*Corresponding Author: [aqilahhalwa@students.usu.ac.id](mailto:aqilahhalwa@students.usu.ac.id)

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### ABSTRACT

**Background:** Congenital Heart Disease (CHD) has become the primary health issue for newborns. Children with CHD who experience the most complications are those with acyanotic CHD. Children with acyanotic CHD experience many clinical disturbances such as shortness of breath, recurrent respiratory infections, cyanosis, and inadequate nutrition intake. This makes children with acyanotic CHD have a higher risk of experiencing cognitive developmental disorders compared to other normal children. **Objective:** This study aims to examine the correlation between acyanotic CHD and cognitive function in children at Adam Malik Hospital in 2022–2023. **Method:** This study is an observational analytic study with a cross-sectional design. The subjects of this study are pediatric patients with acyanotic CHD. Data were obtained from the Denver Developmental Screening Test II cognitive function medical records of 46 patients at Adam Malik Hospital in 2022–2023. Data analysis was conducted using the chi-square hypothesis test. **Results:** This study involved 46 patient samples with acyanotic CHD. The chi-square test results showed no significant correlation between acyanotic CHD and meaningful cognitive function ( $p$ -value = 0.462), where acyanotic CHD did not significantly affect gross motor, fine motor, language, and personal–social functions in children. **Conclusion:** There is no significant correlation between acyanotic CHD and cognitive function in children at Adam Malik Hospital Medan in 2022–2023.

**Keyword:** Acyanotic, children, cognitive function, congenital heart disease, denver developmental screening test II

### ABSTRAK

**Latar Belakang:** Penyakit Jantung Bawaan (PJB) menjadi masalah kesehatan yang paling utama pada anak yang baru lahir. Anak dengan PJB yang paling banyak mengalami gangguan adalah anak dengan PJB asianotik. Anak dengan PJB asianotik mengalami banyak gangguan klinis seperti sesak napas, infeksi saluran napas berulang, sianosis, dan nutrisi yang tidak adekuat. Hal ini membuat anak dengan PJB asianotik memiliki risiko yang lebih tinggi untuk mengalami gangguan perkembangan kognitif dibandingkan dengan anak normal lainnya. **Tujuan:** Penelitian ini untuk mengetahui hubungan antara PJB asianotik dengan fungsi kognitif pada anak di Rumah Sakit Adam Malik Medan tahun 2022–2023. **Metode:** Penelitian ini menggunakan metode analitik observasional dengan desain studi *cross sectional*. Subjek pada penelitian ini adalah pasien anak dengan PJB asianotik. Data diperoleh dari rekam medis fungsi kognitif *Denver Developmental Screening Test II* sebanyak 46 pasien di Rumah Sakit Adam Malik Medan tahun 2022–2023. Analisis data dilakukan dengan uji hipotesis *chi-square*. **Hasil:** Penelitian ini melibatkan 46 sampel pasien dengan PJB asianotik. Hasil uji *chi-square* menunjukkan tidak ada hubungan signifikan antara PJB asianotik dengan fungsi kognitif yang bermakna ( $p$ -value = 0.462), dimana PJB asianotik tidak berpengaruh signifikan terhadap fungsi motorik kasar, motorik halus, bahasa, dan personal–sosial pada anak. **Kesimpulan:** Tidak terdapat hubungan yang signifikan



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antara PJB asianotik dengan fungsi kognitif pada anak di Rumah Sakit Adam Malik Medan tahun 2022–2023.

**Keyword:** Anak, asianotik, *denver developmental screening test II*, fungsi kognitif, penyakit jantung bawaan

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## 1. Introduction

Cardiovascular disease is one of the leading causes of death and disability. A structural and functional abnormalities of the heart that present since pregnancy because of the failure constructing of the heart's structure during the early phases of fetus development is known as congenital heart disease (CHD).<sup>[1]</sup>

Cyanotic CHD and acyanotic CHD are the two categories of congenital heart abnormalities (CHD). Children with acyanotic CHD may experience growth and developmental challenges as a result of the symptoms, which include reduced blood circulation to tissues. In addition, other study mentioned, severe hypoxemia possibly irreversible tissue damage may result if the brain is unable to fulfill the oxygen needs within four to six minutes.<sup>[2]</sup>

Research indicates that CHD may result from advanced gestational age, the mother having systemic diseases, chromosomal abnormalities in the fetus, a history of the mother or father having CHD, and pregnant women who are frequently exposed to cigarette smoke and consume alcohol or harmful medications during pregnancy.<sup>[3]</sup> Additionally, CHD such as ventricular septal defect, atrial septal defect, and tetralogy of fallot are regularly found in around half of down syndrome patients.<sup>[4]</sup>

Congenital heart problems in children are also linked to prenatal variables, such as a history of irregular multivitamin consumption and maternal illnesses during pregnancy. Numerous papers indicate that pregnant women with a history of rubella infection frequently develop congenital cardiac defects such as ventricular septal defect (VSD) and patent ductus arteriosus (PDA). Infectious diseases during pregnancy also play a substantial influence in pregnancy.<sup>[5]</sup> Meanwhile, it has been reported that taking folic acid and multivitamins during the first trimester of pregnancy lowers the number of birth abnormalities by 60%.<sup>[6]</sup> Other studies also mention that a history of pregnant women with prenatal factors such as type 1 or type 2 diabetes, pre-eclampsia in pregnant women, and uncontrolled hypertension or gestational hypertension is associated with the occurrence of CHD. Bardenheier<sup>[7]</sup> estimate that CHD will occur in 5–10% of gestational pregnancies.

Besides all the possible causes of CHD, it is equally essential to study specific clinical symptoms that are common in CHD patients and may lead to developmental issues in children. Based on specific findings of prior studies, untreated shortness of breath is the primary reason why newborns with CHD having trouble while drinking, rapid breathing, shortness of breath or dyspnea, physically exhausted, and lose their appetite. A study at RSUP Dr. Kariadi on 50 patients with CHD revealed that 67.4% of them experienced clinical symptoms such as shortness of breath.<sup>[8]</sup> On the other hand, the patient might present with clinical respiratory tract infections such as a cough, sweating, and struggling to swallow or dysphagia as early clinical signs due to an undiagnosed CHD. Clinical manifestations of recurrent respiratory tract infections appear as a result of unresolved excessive pulmonary circulatory load.<sup>[1]</sup>

Malnutrition is a common manifestation in children with CHD. Malnutrition in patients with CHD may occur due to the symptoms of CHD, which often limits patients ability for daily activities such as eating and drinking. This issue subsequently leads to insufficient nutrient intake, inadequate energy needs, and recurrent respiratory infections associated with CHD. According to research published by the Ministry of Health of the Republic of Indonesia, the predominant symptom in patients with congenital cardiac disease is failure to thrive, occurring at a rate of 61.94%.<sup>[9]</sup> The study indicated that among 95 patients, 75 were acyanotic and 22 were cyanotic, revealing a malnutrition rate of 51.1%, severe malnutrition at 22.3%, and a failure to thrive rate of 64.9%.<sup>[10]</sup>

Furthermore, the Golden Age (0–5 years) is the most important period for a children's growth and development. During this time, children should be provided with various stimuli to ensure the proper development of their physical growth and cognitive functions. Children with CHD are frequently reported to encounter challenges in their developmental progress, particularly in cognitive development. Because they are more prone to illness and frequently encounter other complaints that impede their cognitive development, it is crucial to regularly evaluate the children with acyanotic CHD using the Denver Developmental Screening Test II.<sup>[11]</sup>

Early detection during infancy can decrease mortality rates in children with congenital heart disease (CHD), preserve the quality of life for patients with CHD from childhood, and enable effective surveillance to preserve and maintain a better quality of life for CHD patients throughout their growth and development. Fetal echocardiogram, an ultrasound assessment of the growing fetus inside the womb, is used for early detection of congenital heart disease and will significantly help parents get ready for delivery as well as facilitate early clinical planning and postnatal management. Fetal echocardiography is performed to indicate high-risk pregnancies, such as those with a family history of CHD or other genetic disorders, the use of nonsteroidal anti-inflammatory drugs (NSAIDs) during the third trimester of pregnancy, exposure to teratogens, and a history of certain infections during pregnancy.<sup>[12]</sup>

In a study conducted in 2018, it was stated that medical therapy, such as administering paracetamol (acetaminophen), which is commonly used to treat fever and pain, can be used for pediatric patients with PDA. This study mentioned that the use of paracetamol can close the hole in PDA. It is possible this is related to the inhibition of prostaglandin synthesis, which is known to be a chemical component produced in the body when soft tissue is damaged. Prostaglandins play an important role in keeping the ductus arteriosus open. It is hoped that by administering paracetamol, which suppresses prostaglandin production, it will help close the ductus arteriosus.<sup>[12]</sup>

Cardiac catheterization is the least stressful and safest way to manage hemodynamic stress in CHD. The kind of CHD determines the type of cardiac catheterization. Transcatheter techniques in PDA, transcatheter balloon valvuloplasty in pulmonic stenosis, closing the hole with a pericardial or synthetic patch in ASD, less-invasive catheter-based treatment in VSD, and transcatheter interventions in aortic coarctation are a few common procedures for cardiac catheterizations.<sup>[13]</sup>

Coarctation of the aorta,<sup>[13]</sup> in principle, heart surgery is performed as early as possible to prevent more severe heart defects as the children grows older. When medication and cardiac catheterization are no longer effective in managing the symptoms of CHD, corrective action will be taken using the "circulatory arrest" method. In other cases, corrective surgery must be postponed until a certain age while still performing invasive and palliative surgeries to maintain the patient's quality of life.<sup>[14]</sup>

## 2. Methods

This research was conducted from June to November 2024 at Adam Malik Hospital in Medan. The data for this study were sourced from the medical records of acyanotic CHD patients at Adam Malik Hospital. This study employed a cross-sectional design to examine the correlation between acyanotic CHD and cognitive function in children at Adam Malik Hospital during a one-year period (2022–2023).

This study used consecutive sampling technique, which only collects samples that meet the criteria of the acyanotic CHD patients aged 0–5 years. The main variables used in this study include data available at Adam Malik Hospital and support the research, with the main focus on age, gender, type of acyanotic CHD, Denver Developmental Screening Test II interpretation, and Denver Developmental Screening Test II score results.

Parents and other caregivers will find this examination to be very beneficial in gaining a general understanding of the children's social and academic behaviors. For children ages 0–6, the DDST-II will evaluate a variety of skills, including gross motor development, fine motor development, language development, and personal–social development.<sup>[15]</sup>

The assessment of gross motor skills aims to observe the children's movement and activity, fine motor skills assess how well the children observe and coordinate things, language evaluates how the children follows and speaks and follows directions, and personal–social aspect to assess the children's ability to interact with their environment. According to Çelikkiran, Bozkurt, and Coşkun<sup>[16]</sup> the DDST-II assessment was done on four aspects: advanced, normal, caution, delayed, and no opportunity.

**3. Result**

Congenital heart disease (CHD) remains a significant global health concern due to its prevalence and potential long-term complications. CHD is found in 0.8% of all births, with the majority of CHD cases being acyanotic CHD. CHD is commonly appear with developmental disorders of the brain compared to the normal population.<sup>[17]</sup>

Variable	Frequency (n)	Percentage (%)
<b>Age</b>		
Newborn	1	2.2
Baby	20	43.5
Toddler	25	54.3
<b>Sex</b>		
Male	22	47.8
Female	24	52.2
<b>Type of Congenital Heart Disease</b>		
ASD	28	60.9
VSD	9	19.6
PDA	9	19.6
<b>Interpretation of DDST-II</b>		
Normal	12	26.1
Suspect	34	73.9

Figure 1. Characteristic distributions of acyanotic CHD patients in Haji Adam Malik Hospital

Our findings showed that patients between the ages of two months and one year had the highest frequency of acyanotic CHD (20 patients, 43.5%). This observation indicates that acyanotic CHD is predominantly identified during infancy, a period when clinical signs become more evident and healthcare utilization is relatively high. These findings are consistent with those reported by Katherine, who stated that the majority of CHD patients are diagnosed between 0–5 years of age.<sup>[9]</sup> Similarly, Kumala reported that the highest incidence of acyanotic CHD occurred in children aged 0–1 year.<sup>[11]</sup>

The present investigation demonstrated a sex-related variation in the distribution of acyanotic CHD. Female patients exhibited a higher prevalence of acyanotic CHD compared to male patients (52.2% versus 47.8%, respectively). This finding is consistent with the study conducted by Santosa and Puspa Wardani (2018), which reported that female patients accounted for 79% of individuals diagnosed with acyanotic CHD.<sup>[18]</sup>

Atrial Septal Defect (ASD) was identified as the most prevalent type of acyanotic congenital heart disease (CHD) in the present study, accounting for 28 patients (60.9%), exceeding the frequencies of Ventricular Septal Defect (VSD) and Patent Ductus Arteriosus (PDA). This finding is consistent with the results reported by Manopo (2018) at RSUP Prof. Dr. R. D. Kandou Manado.<sup>[2]</sup>

Interpretation of DDST-II	ASD		VSD		PDA		p-value
	n	%	n	%	n	%	
Normal	5	17.9	3	33.3	1	11.1	0.462
Suspect	23	82.1	6	66.7	8	88.9	

Figure 2. The correlation between cognitive function and acyanotic CHD

Figure 2. shows us that there is no significant correlation between the cognitive function and the incidence of acyanotic CHD ( $p = 0.462$ ). This finding is consistent with the previous study by Mari.<sup>[19]</sup>

Assessment scores of DDST-II	ASD		VSD		PDA		p-value
	n	%	n	%	n	%	
<b>Gross Motor</b>							
Normal	6	21.45	5	55.6	1	11.1	0.067
Suspect	22	78.6	4	44.4	8	88.9	
<b>Fine Motor</b>							
Normal	14	50	7	77.8	4	44.4	0.278
Suspect	14	50	2	22.2	5	55.6	
<b>Language</b>							
Normal	8	28.5	4	44.4	2	22.2	0.558
Suspect	20	71.4	5	55.6	7	77.8	
<b>Personal–Social</b>							
Normal	14	50	6	66.7	4	44.4	0.599
Suspect	14	50	3	33.3	5	55.6	

Figure 3. The correlation between Assessment scores of DDST-II with acyanotic CHD

Our results from DDST-II scoring demonstrated that the incidence of acyanotic CHD and gross motor aspect development did not correlate significantly ( $p = 0.067$ ). These findings are consistent with the study by Kramer and Fischer.<sup>[20]</sup>

For the fine motor aspect, we also found an insignificant correlation between the incidence of acyanotic CHD and fine motor development ( $p = 0.278$ ). The findings reported by Ni were in agreement with the results of the present study, showing that 84 of 113 patients showed normal fine motor aspect development.<sup>[21]</sup>

Language development and the incidence of acyanotic CHD did not substantially link ( $p = 0.558$ ). Permatasari reports that 24 out of 38 patients showed normal language aspect development, which is in line with our findings.<sup>[22]</sup>

The present study did not show a statistically significant association between acyanotic CHD and the personal–social development. This result stands in contrast to the findings reported by Rahmawati, who observed a significant relationship between acyanotic CHD and personal–social development aspect, with a reported p-value of 0.008.<sup>[23]</sup>

#### 4. Conclusion

Based on the discussions and data analysis that have been carried out in this study, it can be concluded that no statistically significant correlation was found between acyanotic congenital heart disease and cognitive function, namely between acyanotic congenital heart disease and gross motor skills, fine motor skills, language, and personal–social skills in children. These findings indicate that, within the study population, children with acyanotic congenital heart disease generally demonstrated developmental outcomes comparable to those observed in children without significant cognitive impairment, as assessed across multiple developmental aspects.

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