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Research Article

Language Disorders in Children with Chronic Cardiac Illness

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Abstract

Background: Preschoolers with chronic heart disease (CHDs) are more likely to experience difficulties with speech and language. According to the majority of research, children with CHD generally have lower-than-average IQs**. Objective:** To assess the impact of CHD on children's language and intelligence. **Methods:** This current study was conducted on 50 children aged from 2 to 7 years and 5 months, and classified into 2 groups: The study group consisted 25 children previously were diagnosed with chronic cardiac diseases and the control group included 25 children without cardiac diseases. Language assessment was done for all children. **Results:** Intelligence quotient and language development had lower scores in revealing decreased neurocognitive function. There were 14 (56%) of children with cardiac diseases had language disorders (48% DLD below average, and 8% MR). **Conclusion:** It was evidenced that children with chronic cardiac illnesses have disordered neurocognitive development in the form of lower IQs and language disorders

Keywords: childhood chronic cardiac illness, Neurocognitive development, language disorders.

Introduction

Congenital heart diseases (CHDs) are structural problems resulting from abnormal development of the heart or major blood artery development [1]. It is the most common kind of pediatric heart disease and the most common congenital lesion. Patients may have impaired brain development [2].

Developmental delays, such as a decrease in cognitive ability and/or particular neurological-psychological impairments, may later follow [3, 4].

Preschoolers with CHDs are more likely to experience difficulties with speech and language [5, 6]. According to the majority of research, children with CHD generally have lower-than-average IQs [7, 8].

Various factors can lead to neuro-developmental disorders that impair brain development in children with heart disease [5].

Reduced cerebral hemodynamic flow and lower umbilical vein oxygen content during pregnancy lead to a reduction in the brain's oxygen supply [9, 10]..

These alterations lead to diminished cerebral growth, especially in the final trimester of pregnancy when energy demands rise [11].

There are other postnatal impacts in addition to the previous abnormalities in brain development and growth. For instance, cerebral blood flow reduction and postnatal hypoxia [12, 13] and decreased cerebral blood flow [14].

Aim of the study:
To assess the impact of chronic heart disease (CHD) on children's language and intelligence

Methods

Subjects and Study Design:
This case control study was carried out at phoniatrics unit in the Minia University Hospital. It included of 50 children aged 2 to 7 years. The study group included 25 children who were previously confirmed with chronic heart diseases, whereas the control group included 25 children who did not have cardiac illnesses.
Children with acute illness, Previous language therapy and Previously diagnosed neurological or psychiatric disorder were excluded.

All children in the Phoniatrics Unit at Minia University Hospital were examined using the language evaluation approach.

I: Preliminary Diagnostic Procedures:

1. Conduct an interview with parents to get information about their complaint, personal history, developmental milestones, neonatal and postnatal periods, and illnesses of early childhood.
2. Neurological and otorhinolaryngology examinations are conducted to rule out any neurological issues.
3. Preliminary evaluation of receptive and expressive language ability using subjective auditory perceptual assessment (APA).

II: Clinical Diagnostic Aids:

1. **Audiological assessment:** included middle ear assessment using tympanometry and recording of acoustic reflex threshold. Auditory assessment was performed using one of the following procedures based on the child's age:
   - Behavioral Observational Audiomety and Free field audiometry.
   - Pure tone audiometry (conventional or conditional).
   - The Auditory Brainstem Response
   .
2. **Psychometric evaluation:**

The Intelligence Quotient is estimated by applying the Stanford Binet Intelligence Scale (5th edition) [15]
.

3. **Language examination:** The Arabic Preschool Language Scale 4 [16]. The primary purpose of this adapted scale is to recognize language abnormalities or impairments in children. The APLS4 has two subscales: auditory comprehension and expressive communication. The standard score for AC, EC, and total language scores are calculated, and a language domain is considered affected if its standard score (SS) is less than 77.5.

Ethical consideration:
Ethical approval was granted by the Ethical Committee of the Faculty of Medicine, Minia University with approval number (350:11/2019). Before data collection, written informed consents were obtained from parents of children after supplying comprehensive information about the nature of the study.

Statistical analysis:
The collected data were coded, tabulated, and statistically analyzed using SPSS program (Statistical Package for Social Sciences) software version 24. Descriptive statistics were done for parametric quantitative data by mean, standard deviation and by number and percentage for qualitative data. Independent samples T-test was used to compare quantitative data between cases and control. Chi square and fissure exact test used to compare qualitative data. Correlation test was used to determine relationship between two quantitative variables. Differences were considered statistically significant at P values < 0.05

Results:

Demographic data revealed there were none statistically significant differences ($P \geq 0.05$) between cases and control groups with respect to age, gender, parent consanguinity, and family similarities. There was a statistically significant variation in prenatal concerns between the two groups, (Table 1).
The study and control groups showed significant differences in first cry timing, and cyanosis at birth ($P < 0.001$). Children with cardiac problems had a significantly higher frequency of mixed feeding than children in the control group, 44% versus 12% respectively, (Table 2).

Regarding the type of treatment for children with cardiac disorders, 19 (76%) were treated conservatively, whereas 6 (24%) had open heart procedures (Figure 1).

Fourteen (56%) of the children with heart illnesses had problems with language (48% DLD below average mentality and 8% MR) (Figure 2).

The study and control groups showed a statistically significant variation in IQ grades (P<0.001), with a mean of 93.8±5.8 in the control group and 82±9.7) in the heart disease group. There was also a statistically significant variation between the two groups on the basis of standard receptive, expressive, and total language scores (Table 3).

There were also non-statistically significant discrepancies between the two treatment lines in terms of IQ and language results (Table 4).

As shown in table 5, positive significant associations were found between IQ and standard scores of expressive, receptive, and the total language, as well as between SS of expressive, receptive, and the total language. There was a negative significant link between parent consanguinity and standard receptive and total language scores, as well as a negative significant correlation between delayed beginning of walking and IQ, expressive, receptive, and the total language scores. There was also a negative significant association between the delayed age of first word utterance and IQ, as well as standard scores for expressive receptive, and the total languages, (Table 5)

Table 1: The demographicdata, family, and prenatal history

	Group		P value
	Control (N=25)	Cardiac diseases (N=25)	
Age (months)			
Range	(25-89)	(25-89)	0.471
Mean±SD	52.5±17.1	48.7±20.2	
Sex			
Male	14(56%)	10(40%)	0.258
Female	11(44%)	15(60%)	
Parent consanguinity			0.185
Negative	21(84%)	17(68%)	
Positive	4(16%)	8(32%)	
Similar condition in family			
Negative	25(100%)	24(96%)	0.991
Positive	0(0%)	1(4%)	
Prenatal history			
Negative	23(92%)	17(68%)	**0.034***
Positive	2(8%)	8(32%)	

Table 2: The perinatal history, developmental milestones and type of feeding

	Group		P value
	Control (N=25)	Cardiac diseases (N=25)	
Perinatal history:			
Type of labor			0.087
Spontaneous vaginal delivery	14(56%)	8(32%)	
Cesarean section	11(44%)	17(68%)	
Weight at birth			
Average	25(100%)	24(96%)	1
Low birth weight	0(0%)	1(4%)	
Time of cry			**0.004***
Immediate	25(100%)	17(68%)	
Delayed	0(0%)	8(32%)	
History of incubation			0.110
Negative	25(100%)	21(84%)	
Positive	0(0%)	4(16%)	

Cyanosis at birth Negative Positive	 25(100%) 0(0%)	 14(56%) 11(44%)	**<0.001***
Jaundice Negative Positive	 16(64%) 9(36%)	 13(52%) 12(48%)	0.390
Type of feeding Breast feeding Artificial feeding Both	 19(76%) 3(12%) 3(12%)	 11(44%) 3(12%) 11(44%)	**0.042***
Developmental milestones:			
Age of walking Average Delayed	 22(88%) 3(12%)	 17(68%) 8(32%)	0.088
Age of first word Average Delayed	 22(88%) 3(12%)	 19(76%) 6(24%)	0.463

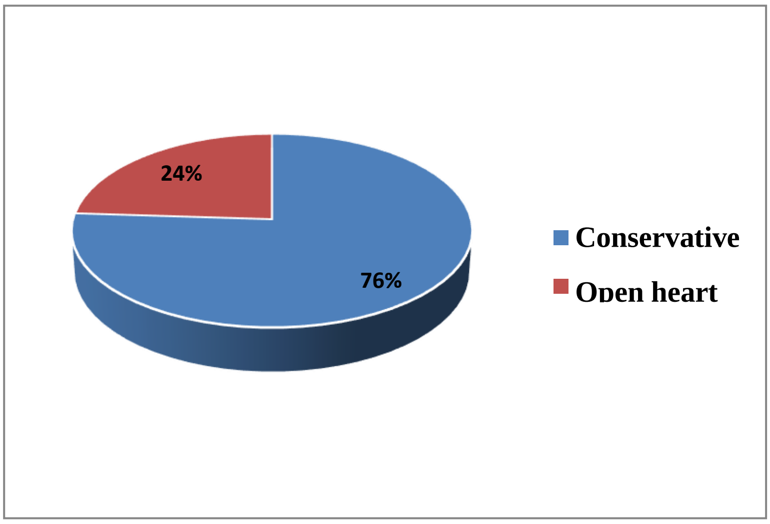

Figure (1): Types of treatment in cardiac diseases

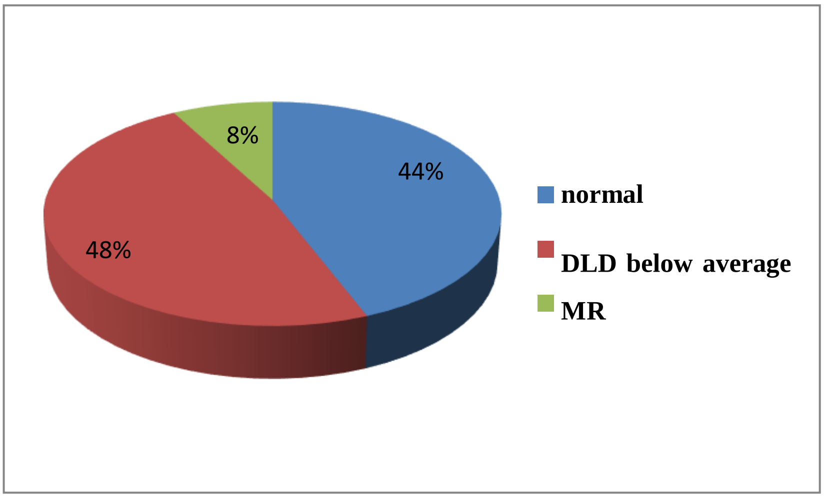

Figure 2: Language problems in children with cardiovascular illnesses (n=25)

Table 3: IQ and language test

		Group		P value
		Control	Cardiac diseases	
		N=25	N=25	
IQ	Range Mean ± SD	(82-106) 93.8±5.8	(61-98) 82±9.7	**<0.001***
SS of receptive language	Range Mean ± SD	(50-119) 90.9±17.7	(50-124) 79±22.7	**0.045***
	Not affected Affected	21(84%) 4(16%)	13(52%) 12(48%)	**0.015***
SS of expressive language	Range Mean ± SD	(46-112) 85±18.9	(50-125) 74.6±24.5	0.097
	Not affected Affected	19(76%) 6(24%)	11(44%) 14(56%)	**0.021***
SS of total language	Range Mean ± SD	(50-119) 88.5±19.1	(50-124) 76.6±25.5	0.069
	Not affected Affected	21(84%) 4(16%)	11(44%) 14(56%)	**0.003***

Table 4: Comparison between conservative and surgical treatment in children with cardiac diseases regarding IQ, and language test

		Type of treatment		P value
		Conservative	Open heart	
		N=19	N=6	
IQ	Range Mean ± SD	(66-98) 82.7±9.3	(61-88) 79.8±11.5	0.533
SS of receptive language	Range Mean ± SD	(50-124) 80.3±24.7	(53-96) 75.0±16	0.627
	Not affected Affected	11(57.9%) 8(42.1%)	2(33.3%) 4(66.7%)	0.294
SS of expressive language	Range Mean ± SD	(50-125) 77.3±27	(50-78) 65.8±11.5	0.155
	Not affected Affected	9(47.4%) 10(52.6%)	2(33.3%) 4(66.7%)	0.546
SS of total language	Range Mean ± SD	(50-124) 80.1±27.4	(50-85) 65.7±15.1	0.122
	Not affected Affected	9(47.4%) 10(52.6%)	2(33.3%) 4(66.7%)	0.546

Table 5: Correlation among SS, IQ language scores, and different historical items in children with heart problems

Cardiac diseases group	**IQ**		**SS of receptive language**		**SS of expressive language**		**SS of total language**	
	r	**P value**	**r**	**P value**	**r**	**P value**	**r**	**P value**
SS of receptive language	**0.822**	**<0.001***						
SS of expressive language	**0.834**	**<0.001***	**0.914**	**<0.001***				
SS of total language	**0.845**	**<0.001***	**0.9 64**	**<0.001***	**0.980**	**<0.001***		
Positive parent consanguinity	-0.298	0.148	**-0.488**	**0.013***	-0.346	0.090	**-0.452**	**0.023***
Similar condition in family	-0.199	0.341	-0.170	0.416	-0.071	0.736	-0.142	0.499
Positive prenatal history	0.072	0.734	-0.214	0.303	-0.083	0.692	-0.089	0.671
LBW	-0.114	0.589	-0.340	0.096	-0.298	0.148	-0.312	0.129
Delayed time of cry	-0.119	0.570	0.006	0.977	-0.030	0.887	-0.071	0.734
History of incubation	0.349	0.087	0.099	0.639	0.061	0.773	0.061	0.774
Cyanosis at birth	-0.090	0.670	-0.134	0.522	0.011	0.958	-0.039	0.853
Jaundice	-0.050	0.812	-0.300	0.145	-0.345	0.091	-0.300	0.145
Delayed onset of walking	**-0.656**	**<0.001***	-0.524	**0.007***	**-0.519**	**0.008***	**-0.536**	**0.006***
Delayed age of first word	**-0.612**	**0.001***	**-0.559**	**0.004***	**-0.554**	**0.004***	**-0.637**	**0.001***

Discussion

In terms of prenatal concerns, a statistically significant difference was discovered between children with cardiac diseases and controls. Eight of twenty-five moms of infants with cardiac disorders reported these problems, which included preeclampsia (five), anemia (one), first trimester hemorrhage (one), and steroid use during pregnancy. Preeclampsia and maternal anemia can alter the placenta, increasing the risk of fetal hypoxia and congenital defects such as CHD. Furthermore, prenatal steroid use may cause congenital malformations and disturbed fetal development. This was consistent with Yilgwan, Pam[17], who suggested that preeclamptic moms may raise their infants' risk of CHD. In line with Kalisch-Smith, Ved [18] hypothesized that maternal anemia may increase the risk of CHD development.

The time of the initial cry and the incidence of cyanosis at birth differed significantly between the research and control groups. This is owing to the cyanotic nature of different heart problems, as stated by Humayun and Atiq [19], who estimate that cyanotic congenital heart illnesses account for around 25% of cardiac anomalies.

According to Grifka [20], children with cyanotic CHD can develop cyanosis for one of two reasons: either there is insufficient blood flow to the lungs, or a significant volume of deoxygenated blood is pumped to the body (systemic circulation) and a significant amount of oxygenated blood is pushed back to the lungs (along with some blue blood).

In terms of feeding style, children with cardiac issues had a considerably higher frequency of mixed breast-and-formula feedings than children in the control group, who breastfed more frequently. This is explained by the fact that incorporating bottle formula feeding into some meals makes feeding easier and needs less effort, as children with cardiac diseases may experience feeding difficulties and early tiredness due to shortness of breath.This is consistent with Jones and Desai [21], who stated that children with CHD frequently experience oral feeding difficulties as a result of medical conditions, delayed transition to oral feeding, oral feeding rejection, developmental delays, and the effects of the stressful intensive care unit (ICU).

The control group had a mean IQ score of 93.8±5.8, while the cardiac disease group had a mean IQ score of 82±9.7, indicating a significant difference (P<0.001). This could be due to hypoxia's negative effects on the brain and cognitive function, prolonged hospitalization, medical and surgical complications. This was similar with [7], who showed that the primary indicators of risk for neurodevelopmental problems in children with CHD were low birth weight, long hospitalizations in the NICU, low socioeconomic status, and post-operative seizures. This was also consistent with numerous studies, which found that children with CHD had lower-than-average total IQ scores [7, 8].

Furthermore, a significant difference was discovered between the two groups in terms of, expressive, receptive and total language standard scores. This is because children with cardiac issues have lower IQs, long term hospitalization causes environmental deprivation, and hypoxia has a negative impact on neurodevelopment.

This was consistent with the findings of Hövels-Gürich, Bauer [6] and Liamlahi and Latal [5], who found a higher frequency of verbal impairments in preschool-aged children with CHD. Also, confirmed with recent studies by Karmacharya, Gagoski [22] and Sommariva, Zilli [3], who found that children with CHD may have substantial abnormalities in the brain networks important for language processing.

According to Cassidy, Ilardi [23] and Sarrechia, Miatton [24], children with CHDs have well preserved cognitive abilities, including language.

In terms of language outcomes and IQ, the conservative and surgical treatment approaches did not differ statistically significantly. This could be due to recent advances in surgical procedures, which provide better results, have less side effects, and need shorter hospital stays. This contradicted Mussatto, Hoffmann [4] and Sommariva, Zilli's [3] claims that infants who have undergone cardiac surgery are more prone to experience early language difficulties.

Positive substantial associations were found between standard scores and IQ for, receptive, expressive, and the total language.This is because there is a substantial association between IQ and language development. This is consistent with Chomsky [25], who discovered a significant relationship between language development and IQ across all levels.

There was a strong negative connection between parental consanguinity and standard total and receptive language scores. This could be attributed to socioeconomic status and genetics. This is consistent with Sunderajan and Kanhere's [26] finding that consanguinity is a risk factor for language delay. This could be due to a genetic etiology, as proposed by Andres and Hafeez [27], who investigated the link between SLI and consanguinity.

There was a strong negative association between IQ and delayed walking, as well as standard scores for expressive, receptive, and total languages. Language development may be slowed by the child's limited environmental exploration as a result of lower motor development. This was consistent with Viholainen and Ahonen [28], who stated that there is a strong relation that motor development and language are interconnected, and that an early delay in language development may be linked to an early delay in motor development.

Conclusion

It was evidenced that children with chronic cardiac illnesses have disordered neurocognitive development in the form of lower IQs and language disorders.

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