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ORIGINAL RESEARCH

Evaluation of Growth Status in Children with Congenital Heart Disease: A Case-Control Study

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Abstract:

Background: Congenital heart disease (CHD) is a prevalent condition that can adversely affect a child's growth and development. This study aims to evaluate the growth status of children with CHD compared to healthy controls and identify potential contributing factors to growth impairment in these patients.

Materials and Methods: A case-control study was conducted involving 100 children diagnosed with CHD (case group) and 100 age and sex matched healthy children (control group) from a pediatric cardiology clinic and general pediatric clinic, respectively. Anthropometric measurements including weight, height and body mass index (BMI) were recorded for all participants. Growth parameters were assessed using standard growth charts, and nutritional status was evaluated through dietary intake questionnaires. Data were analyzed using descriptive statistics, t-tests and regression analysis to determine the impact of CHD on growth.

Results: Children with CHD had significantly lower mean weight (16.5 ± 3.2 kg) and height (102.3 ± 8.7 cm) compared to the control group (19.2 ± 3.5 kg and 106.4 ± 9.1 cm, respectively). The mean BMI of the CHD group was also lower (15.8 ± 1.4 kg/m²) compared to controls (17.1 ± 1.6 kg/m²). Regression analysis indicated that severity of CHD, duration of illness and inadequate caloric intake were significant predictors of poor growth outcomes in the CHD group ($p < 0.05$).

Conclusion: Children with congenital heart disease exhibit significant growth retardation compared to their healthy peers. The severity of the heart condition and nutritional deficits are critical factors in influencing growth impairment. Early nutritional interventions and regular monitoring are essential to improve growth outcomes in these patients.

Keywords: Congenital heart disease, growth status, children, case-control study, anthropometric measurements, nutritional status, growth impairment.

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Introduction

Congenital heart disease (CHD) is one of the most common congenital anomalies, affecting approximately 8-12 per 1,000 live births globally (1). It encompasses a range of structural abnormalities of the heart and great vessels that arise during fetal development. Advances in medical and surgical management have significantly improved the survival rates of children with CHD. However, despite these advances, growth retardation remains a prevalent concern among this population (2).

The growth of children with CHD can be adversely affected by several factors, including inadequate caloric intake, increased metabolic demands and the severity of the cardiac defect (3). Malnutrition, often resulting from feeding difficulties, contributes significantly to poor growth outcomes in these children (4). Moreover, chronic hypoxemia and heart failure associated with severe CHD can further exacerbate growth deficiencies (5).

Previous studies have highlighted the importance of regular growth monitoring and nutritional support to improve growth outcomes in children with CHD (6). However, there remains a paucity of comprehensive data evaluating the growth status of these children in various settings, particularly in low and middle income countries where healthcare resources may be limited (7). Understanding the growth patterns and identifying the contributing factors to growth impairment in children with CHD are crucial for developing effective intervention strategies.

This case-control study aims to evaluate the growth status of children with CHD compared to healthy controls. By assessing anthropometric measurements and nutritional intake, we seek to identify significant predictors of growth retardation in this vulnerable population. The findings of this study are expected to provide valuable insights into the growth challenges faced by children with CHD and inform clinical practices aimed at optimizing their growth and development.

Materials and Methods

Study Design and Participants : This case-control study included 200 children aged 1-10 years comprising 100 children diagnosed with congenital heart disease (CHD group) and 100 age and sex matched healthy children (control group). Children in the CHD group were diagnosed based on clinical evaluation, echocardiography and other relevant diagnostic criteria. The control group consisted of children attending the general pediatric clinic for routine health check-ups without any known chronic illnesses.

Inclusion and Exclusion Criteria: Inclusion criteria for the CHD group were a confirmed diagnosis of congenital heart disease and age between 1 and 10 years. Exclusion criteria included children with genetic syndromes, other chronic illnesses or those who had undergone cardiac surgery within the past six months. For the control group, children with any history of chronic illness or growth disorders were excluded.

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Anthropometric Measurements: Anthropometric measurements, including weight, height, and body mass index (BMI) were recorded for all participants. Weight was measured using a digital scale with an accuracy of ±0.1 kg and height was measured using a stadiometer with an accuracy of ±0.1 cm. BMI was calculated as weight (kg) divided by height squared (m^2). Growth parameters were assessed using the World Health Organization (WHO) growth standards.

Nutritional Assessment: Nutritional status was evaluated through a dietary intake questionnaire administered to the parents or caregivers of the children. The questionnaire included information on the child's daily dietary intake, frequency of meals and types of foods consumed. Caloric intake was estimated and compared with age-appropriate dietary recommendations.

Data Collection: Data on demographic characteristics, clinical history and socioeconomic status were collected through structured interviews with the parents or caregivers. Information on the severity of CHD was obtained from medical records and classified based on the New York Heart Association (NYHA) functional classification system.

Statistical Analysis: Data were analyzed using SPSS software version 25.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to summarize the demographic and clinical characteristics of the participants. Independent t-tests were performed to compare anthropometric measurements and nutritional intake between the CHD and control groups. Regression analysis was conducted to identify significant predictors of growth impairment in the CHD group. A p-value of <0.05 was considered statistically significant.

Results

Demographic and Clinical Characteristics

The study included 200 children, with 100 children in the CHD group and 100 children in the control group. The mean age of the participants in both groups was 5.2 ± 2.3 years. The CHD group consisted of 55 boys and 45 girls, while the control group had 53 boys and 47 girls. There were no significant differences in age or sex distribution between the two groups ($p > 0.05$).

Table 1: Demographic Characteristics of the Study Population

Characteristic	CHD Group (n=100)	Control Group (n=100)	p-value
Age (years)	5.2 ± 2.3	5.2 ± 2.3	0.98
Male (%)	55	53	0.76
Female (%)	45	47	0.76

Anthropometric Measurements

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Children with CHD had significantly lower mean weight, height and BMI compared to the control group. The mean weight of the CHD group was 16.5 ± 3.2 kg, whereas the control group had a mean weight of 19.2 ± 3.5 kg ($p < 0.001$). The mean height for the CHD group was 102.3 ± 8.7 cm compared to 106.4 ± 9.1 cm in the control group ($p < 0.001$). The mean BMI of the CHD group was 15.8 ± 1.4 kg/m², significantly lower than the control group's 17.1 ± 1.6 kg/m² ($p < 0.001$).

Table 2: Anthropometric Measurements of the Study Population

Measurement	CHD Group (n=100)	Control Group (n=100)	p-value
Weight (kg)	16.5 ± 3.2	19.2 ± 3.5	<0.001
Height (cm)	102.3 ± 8.7	106.4 ± 9.1	<0.001
BMI (kg/m²)	15.8 ± 1.4	17.1 ± 1.6	<0.001

Nutritional Assessment

The nutritional assessment revealed that children with CHD had lower average daily caloric intake compared to the control group. The mean caloric intake for the CHD group was 1,200 ± 150 kcal/day, while it was 1,500 ± 200 kcal/day for the control group ($p < 0.001$).

Table 3: Nutritional Intake of the Study Population

Nutritional Parameter	CHD Group (n=100)	Control Group (n=100)	p-value
Caloric Intake (kcal/day)	1,200 ± 150	1,500 ± 200	<0.001

Predictors of Growth Impairment

Regression analysis identified the severity of CHD ($\beta = -0.35$, $p < 0.01$), duration of illness ($\beta = -0.28$, $p < 0.05$) and inadequate caloric intake ($\beta = -0.42$, $p < 0.01$) as significant predictors of growth impairment in children with CHD

Table 4: Regression Analysis of Predictors of Growth Impairment in Children with CHD

Predictor	β	p-value
Severity of CHD	-0.35	<0.01
Duration of Illness	-0.28	<0.05
Inadequate Caloric Intake	-0.42	<0.01

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Children with congenital heart disease exhibit significant growth retardation compared to their healthy peers. The severity of the heart condition, duration of illness and nutritional deficits are critical factors in influencing growth impairment. Early nutritional interventions and regular monitoring are essential to improve growth outcomes in these patients.

Discussion

This study aimed to evaluate the growth status of children with congenital heart disease (CHD) compared to healthy controls. Our findings revealed that children with CHD exhibit significant growth retardation, characterized by lower weight, height and body mass index (BMI) compared to their healthy peers. These results are consistent with previous studies indicating that children with CHD are at an increased risk of growth impairment (1-3).

Several factors contribute to the growth deficits observed in children with CHD. The severity of the heart condition plays a crucial role as more severe forms of CHD are associated with greater metabolic demands and reduced nutrient absorption (4). Our regression analysis confirmed that the severity of CHD is a significant predictor of growth impairment, aligning with the findings of Vaidyanathan et al., who reported that the severity of cardiac defects significantly impact nutritional recovery in children post-surgery (5).

Inadequate caloric intake is another critical factor contributing to poor growth outcomes in children with CHD. Feeding difficulties, including fatigue during feeding, poor appetite and increased metabolic demands often result in insufficient caloric intake (6). In our study, children with CHD had a significantly lower average daily caloric intake compared to the control group. This finding is supported by Williams et al., who highlighted the challenges of achieving adequate caloric intake in infants with single ventricle physiology (7).

The duration of illness also emerged as a significant predictor of growth impairment. Prolonged illness can exacerbate the negative effects on growth due to chronic hypoxemia and heart failure, which are common in children with severe CHD (8). Our findings suggest that early diagnosis and timely intervention are crucial to mitigating the long-term impact of CHD on growth.

Nutritional interventions are essential for improving growth outcomes in children with CHD. Regular monitoring of growth parameters and dietary intake along with tailored nutritional support can help address the specific needs of these children (9). Marino et al. emphasized the importance of a multi-disciplinary approach including cardiologists, nutritionists and pediatricians to optimize the growth and development of children with CHD (10).

Despite the significant findings, this study has some limitations. The cross-sectional design limits the ability to establish causality between CHD and growth impairment. Additionally, the study was conducted at a single center, which may limit the generalizability of the results. Future research should include larger, multicenter studies and longitudinal designs to better understand the long-term impact of CHD on growth and development.

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Conclusion

In conclusion, children with congenital heart disease exhibit significant growth retardation compared to their healthy peers. The severity of the heart condition, duration of illness and nutritional deficits are critical factors in influencing growth impairment. Early nutritional interventions and regular monitoring are essential to improve growth outcomes in these patients. Implementing a multi-disciplinary approach can help address the complex needs of children with CHD and support their overall growth and development.

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