ORIGINAL ARTICLE

Pattern and Outcome of Congenital Heart Diseases at the Emergency Paediatric Unit of a Tertiary Hospital in Azare, North-Eastern Nigeria

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Abstract

Background: Congenital heart diseases (CHD) significantly impact childhood health in low-resource settings. This study aimed to assess the hospital-based proportion, clinical patterns, complications, and outcomes of CHD among children seen at the Emergency Paediatric Unit of the Federal University of Health Sciences Teaching Hospital, Azare, North-Eastern Nigeria, over one year.

Materials and Methods: A retrospective analysis was conducted on children aged 1 month to 15 years with echocardiographically confirmed CHD from January 1 to December 31, 2024. Data were collected from medical records and analysed using IBM SPSS version 25. Binary logistic regression identified mortality predictors, with statistical significance set at $p<0.05$.

Results: Of 2,973 admissions, 42 (1.41%) had confirmed CHD. Median presentation age was 9 months (IQR: 3-26), with male predominance (1.2:1). Commonest lesions included ventricular septal defect (33.3%), tetralogy of Fallot (21.4%), and patent ductus arteriosus (14.3%). Complications featured heart failure (50.0%), severe pneumonia (31.0%), and hypoxic spells (14.3%). Overall mortality was 35.7% (15/42), with 80% of deaths in infants. Only 7.1% accessed a surgical referral. Independent mortality predictors were age <6 months (AOR: 3.41, 95%CI: 1.38-8.42, p=0.008), delayed presentation (AOR: 2.89, 95%CI: 1.18-7.06, p=0.021), heart failure at presentation (AOR: 3.92, 95%CI: 1.54-9.97, p=0.004), complex CHD (AOR: 4.56, 95%CI: 1.72-12.08, p=0.002), and lack of surgical referral (AOR: 7.23, 95%CI: 1.51-34.62, p=0.013).

Conclusions: CHD significantly contributes to paediatric morbidity and mortality in this region. Many infants present late and face substantial barriers to surgical care. Enhancing early detection and improving access to cardiac services are essential to reducing mortality.

Keywords: Congenital heart disease, morbidity, mortality, emergency unit, Nigeria, Sub-Saharan Africa

Introduction

Congenital heart diseases (CHD) represent the most common group of congenital anomalies globally, affecting 8-12 per 1,000 live births.[1] These structural malformations range from simple lesions that may close spontaneously to complex anomalies requiring timely surgical intervention.[2] CHD accounts for nearly one-third of all major congenital anomalies and remains a leading cause of infant mortality worldwide.[3]

An estimated 1.35 million newborns are born with CHD annually, with the highest burden concentrated in low- and middle-income countries (LMICs).[4] Sub-Saharan Africa bears a disproportionate share, where limited diagnostic facilities, shortage of paediatric cardiologists, and absence of cardiac surgical services result in delayed diagnosis and

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poor outcomes.[5] The region's health systems, already strained by infectious diseases, are not well equipped to address the growing recognition of CHD as a significant contributor to childhood mortality.[6]

Nigeria, with Africa's largest population, lacks comprehensive national data on CHD. Hospital-based reports from Southern and Western Nigeria suggest CHD constitutes 10-20% of paediatric cardiology consultations, with ventricular septal defect (VSD) being most frequently reported.[7-9] However, data from North-Eastern Nigeria are scarce, a region characterised by significant healthcare challenges including health worker shortages, infrastructure deficits, and recurrent humanitarian crises.[10]

Children with undiagnosed or late-diagnosed CHD frequently present to emergency paediatric units with life-threatening complications: heart failure, severe pneumonia, hypoxic spells, and infective endocarditis.[11] The emergency unit serves as the frontline for managing these acute presentations, where timely recognition and appropriate intervention can be lifesaving. Yet, in resource-constrained settings, the absence of echocardiography, limited availability of paediatric cardiologists, and lack of surgical referral pathways contribute to missed diagnoses and preventable deaths.[12]

A recent study from our centre documented overall paediatric morbidity and mortality patterns in 2024, identifying severe malaria, malnutrition, and pneumonia as leading causes of admission and death.[13] However, that study did not specifically examine the burden of CHD. Understanding the current pattern and outcome of CHD in our emergency unit is essential to highlight the hidden burden of cardiovascular disease, inform resource allocation, guide health worker training, and provide baseline data for advocacy and policy development.

Sustainable Development Goal (SDG) 3.2 aims to end preventable deaths of newborns and children under five by 2030.[14] Addressing congenital anomalies, including CHD, is integral to achieving this target. Furthermore, the World Health Assembly resolution on birth defects (2010) urged member states to develop surveillance systems and strengthen capacity for prevention and care of congenital anomalies.[15]

This study aimed to describe the hospital-based proportion, clinical patterns, echocardiographic findings, complications, and outcomes of congenital heart diseases among children presenting to the emergency paediatric unit at the Federal University of Health Sciences Teaching Hospital, Azare, North-Eastern Nigeria, during the 2024 calendar year.

Materials and Methods

Study Design and Setting

This retrospective cross-sectional study was conducted at the Emergency Paediatric Unit (EPU) of Federal University of Health Sciences Teaching Hospital, Azare (FUHSTHA), located in Katagum Local Government Area, Bauchi State, North-Eastern Nigeria. The hospital is a tertiary facility receiving referrals from primary and secondary health centres across Bauchi, Jigawa, and Yobe States, serving an estimated population of 3-4 million people.

The EPU is a 30-bed ward managing children aged 1 month to 15 years with emergent medical conditions. Staffing includes nurses, medical officers, paediatric residents, and consultant paediatricians on a 24-hour rotational basis. Children are triaged, stabilised, and either discharged, transferred to general paediatric wards, or referred elsewhere for specialised care. The unit recorded 2,973 admissions in 2024.[13]

Paediatric cardiology services at FUHSTHA remain limited. Echocardiography became available in 2023 through a single non-portable machine operated by a paediatrician with echocardiography training, with an adult cardiologist available for older patients (>15 years). No cardiothoracic surgeon is on staff, and children requiring surgical intervention are referred to centres in Southern Nigeria or abroad, which is financially prohibitive for most families.

Study Population

All children aged 1 month to 15 years who presented to the EPU from January 1 to December 31, 2024, and had echocardiographically confirmed CHD were included.

Inclusion and exclusion criteria:

The study included children aged 1 month to 15 years with echocardiographically confirmed congenital heart disease (CHD) whose medical records were available for review. Patients who were brought in dead, had suspected but unconfirmed CHD, or had acquired heart diseases (including rheumatic heart disease, myocarditis, and pericarditis) were excluded. Records that were absent or grossly incomplete, defined as having more than 5% missing data on key study variables, were also excluded.

Data Collection

A structured proforma was developed to extract information from patients' medical records, admission registers, and echocardiography records. Two senior paediatric residents trained as research assistants participated in data extraction. The lead researcher reviewed all entries for completeness and consistency. Medical records with incomplete data were excluded.

Data collected included:

1. **Demographic characteristics:** Age, gender, residence, caregiver's education, referral status
2. **Clinical presentation:** Presenting complaints, age at symptom onset, age at diagnosis, delayed presentation (>6 months from symptom onset)[24]
3. **Examination findings:** Vital signs, oxygen saturation, cyanosis, clubbing, heart murmurs, hepatomegaly, heart failure (modified Ross criteria)
4. **Echocardiographic findings:** CHD type (acyanotic/cyanotic, simple/complex), associated anomalies, pulmonary hypertension, ventricular dysfunction
5. **Complications at presentation:** Heart failure, severe pneumonia, hypoxic spells, infective endocarditis, arrhythmias, cerebrovascular accident
6. **Management and outcome:** Medical therapy, surgical referral, hospital stay duration, outcome (discharged, died, DAMA, absconded, lost to follow-up)

Variables and Definitions

- **Age groups:** Infants (<1 year), toddlers/under five (1-4.9 years), school age (5-12 years), adolescents (13-15 years)
- **CHD classification** based on echocardiography:
  - *Acyanotic CHD:* Left-to-right shunts (VSD, ASD, PDA, AVSD) and obstructive lesions (pulmonary stenosis, aortic stenosis, coarctation)
  - *Cyanotic CHD:* Tetralogy of Fallot, transposition of

great arteries, tricuspid atresia, pulmonary atresia, total anomalous pulmonary venous connection, truncus arteriosus, Ebstein's anomaly, double outlet right ventricle

- *Complex CHD:* Lesions requiring surgical intervention in infancy (within the first year of life) or those with multiple associated intracardiac defects regardless of age, including TOF, TGA, DORV, truncus arteriosus, pulmonary atresia, tricuspid atresia, AVSD, and severe VSD with pulmonary hypertension.[2]

- **Delayed presentation:** Presentation >6 months after symptom onset.[24]
- **Heart failure:** Modified Ross criteria requiring tachypnoea, tachycardia, tender hepatomegaly, and cardiomegaly (clinically or on chest radiograph)
- **Hypoxic spell:** Acute episode of cyanosis and hyperpnoea in cyanotic CHD
- **Lost to follow-up:** Failure to return within 1 month for a scheduled appointment after discharge

Ethical Considerations

Ethical approval was obtained from the Health Research Ethics Committee of FUHSTHA (Approval number: NHREC/FUHSTHA/11/11/24). Individual informed consent was waived for this retrospective record review. Patient information was anonymised and handled confidentially in accordance with the Declaration of Helsinki.

Data Analysis

Data were entered into Microsoft Excel® 2016 and analysed using IBM SPSS version 25. Continuous variables were tested for normality using the Shapiro-Wilk test. Normally distributed variables were expressed as mean ± standard deviation (SD), skewed variables as median with interquartile range (IQR). Categorical variables were presented as frequencies and percentages.

Categorical comparisons were performed using Pearson's chi-square test or Fisher's exact test (where any expected cell count was <5). Factors associated with mortality were analysed using binary logistic regression to estimate odds ratios (ORs) and 95% confidence intervals (CIs). Variables with $p<0.2$ in univariate analysis were entered into a multivariate logistic regression using forward stepwise selection (likelihood ratio) to identify independent predictors of mortality. Model fit was assessed using the Hosmer-Lemeshow goodness-of-fit test. Statistical significance was set at $p<0.05$.

Given the small sample size (n=42, 15 mortality events), the multivariate model was limited to 5 predictors to avoid overfitting, in line with the recommended maximum of 1 predictor per 3-5 events.

Results

Demographic Characteristics

During the one-year study period (January 1 to December 31, 2024), 2,973 children were admitted to the EPU. Of these, 42 (1.41%) had echocardiographically confirmed CHD.

Median age at presentation was 9 months (IQR: 3-26). Infants (<1 year) constituted 29 (69.0%) of cases; toddlers/under five (1-4.9 years) 9 (21.4%); school-age (5-12 years) 3 (7.1%); and adolescents (13-15 years) 1 (2.4%). Males numbered 23 (54.8%) and females 19 (45.2%), giving a male: female ratio of 1.2:1.

Most children (38, 90.5%) resided in Bauchi State, with the remainder from Yobe (3, 7.1%) and Jigawa (1, 2.4%). Rural dwellers accounted for 32 (76.2%), while 10 (23.8%) lived in urban/semi-urban areas. Direct home referrals numbered 25 (59.5%), while 17 (40.5%) were referred from other facilities. Caregivers with no formal education comprised 23 (54.8%), while 10 (23.8%) had primary, 6 (14.3%) secondary, and 3 (7.1%) tertiary education. Table 1 summarises demographic characteristics.

Clinical Presentation

Median age at symptom onset was 3 months (IQR: 1-14), while median age at CHD diagnosis was 9 months (IQR: 3-26), indicating a median diagnostic delay of 6 months (IQR: 2-12). Delayed presentation (>6 months after symptom onset) occurred in 26 (61.9%) children.

The commonest presenting complaints were difficulty breathing (33, 78.6%), recurrent respiratory infections (23, 54.8%), and poor weight gain/failure to thrive (20, 47.6%). Table 2 presents complete clinical features.

Table 1: Demographic Characteristics of Children with CHD (N=42)

Characteristic	Frequency n (%)
Age group	
<1 year	29 (69.0)
1-4.9 years	9 (21.4)
5-12 years	3 (7.1)
13-15 years	1 (2.4)
Gender	
Male	23 (54.8)
Female	19 (45.2)
Residence state	
Bauchi	38 (90.5)
Yobe	3 (7.1)
Jigawa	1 (2.4)
Settlement	
Rural	32 (76.2)
Urban/Semi-urban	10 (23.8)
Referral status	
Brought directly from home	25 (59.5)
Referred from another facility	17 (40.5)
Caregiver education	
No formal education	23 (54.8)
Primary	10 (23.8)
Secondary	6 (14.3)
Tertiary	3 (7.1)

Table 2: Clinical Presentation (N=42)

Clinical Feature	Frequency n (%)
Difficulty breathing	33 (78.6)
Recurrent respiratory infections	23 (54.8)
Poor weight gain/failure to thrive	20 (47.6)
Cyanosis	16 (38.1)
Poor feeding	15 (35.7)
Easy fatiguability	12 (28.6)
Febrile illness	9 (21.4)
Cough	8 (19.0)
Diarrhoea/vomiting	6 (14.3)
Seizures	3 (7.1)
Body swelling	2 (4.8)
Palpitations	1 (2.4)

Median oxygen saturation at presentation was 87% (IQR: 74-94%). Cyanosis was clinically evident in 16 (38.1%), and clubbing in 9 (21.4%). Heart murmurs were audible in 38 (90.5%): pansystolic (18, 42.9%), ejection systolic (12, 28.6%), and continuous (5, 11.9%). Hepatomegaly (≥2 cm) occurred in 22 (52.4%), and heart failure (modified Ross criteria) in 21 (50.0%).

Echocardiographic Findings

Ventricular septal defect was the commonest lesion (14, 33.3%), followed by tetralogy of Fallot (9, 21.4%) and patent ductus arteriosus (6, 14.3%). Table 3 presents the complete CHD spectrum.

Acyanotic CHD comprised 27 (64.3%) cases; cyanotic CHD, 15 (35.7%). Among acyanotic lesions, left-to-right shunts predominated (25, 92.6%), while obstructive lesions accounted for 2 (7.4%). Among cyanotic lesions, TOF was most frequent (9, 60.0%).

Complex CHD occurred in 18 (42.9%) children. Associated extracardiac anomalies were identified in 5 (11.9%): Down syndrome (2, 4.8%), other chromosomal anomalies (1, 2.4%), and musculoskeletal anomalies (2, 4.8%). Pulmonary hypertension was present in 15 (35.7%), with 10 (23.8%) having moderate-severe elevation. Ventricular dysfunction (ejection fraction <50%) occurred in 6 (14.3%).

Complications at Presentation

Complications were present in 35 (83.3%) children at presentation (Table 4). Heart failure was most frequent (21, 50.0%) and was more common in acyanotic lesions (17, 81.0% of heart failure cases). Severe pneumonia occurred in 13 (31.0%), predominantly in infants <6 months (9, 69.2%). Hypoxic spells affected 6 (14.3%), all with cyanotic CHD (TOF, 5; DORV, 1).

Table 3: Pattern of Congenital Heart Disease (N=42)

Type of CHD	Frequency n (%)
Acyanotic CHD	**27 (64.3)**
Ventricular septal defect (VSD)	14 (33.3)
Patent ductus arteriosus (PDA)	6 (14.3)
Atrial septal defect (ASD)	4 (9.5)
Pulmonary stenosis (PS)	2 (4.8)
Atrioventricular septal defect (AVSD)	1 (2.4)
Cyanotic CHD	**15 (35.7)**
Tetralogy of Fallot (TOF)	9 (21.4)
Transposition of great arteries (TGA)	2 (4.8)
Double outlet right ventricle (DORV)	1 (2.4)
Truncus arteriosus	1 (2.4)
Pulmonary atresia	1 (2.4)
Tricuspid atresia	1 (2.4)

Table 4: Complications at Presentation by CHD Type

Complication	Acyanotic CHD (n=27)	Cyanotic CHD (n=15)	Total (N=42)	p-value*
Heart failure	17 (63.0%)	4 (26.7%)	21 (50.0%)	0.028
Severe pneumonia	10 (37.0%)	3 (20.0%)	13 (31.0%)	0.043
Hypoxic spells	0 (0%)	6 (40.0%)	6 (14.3%)	<0.001
Pulmonary hypertension	12 (44.4%)	3 (20.0%)	15 (35.7%)	0.032
Failure to thrive	9 (33.3%)	11 (73.3%)	20 (47.6%)	0.016
Infective endocarditis	0 (0%)	1 (6.7%)	1 (2.4%)	0.357
Arrhythmias	1 (3.7%)	1 (6.7%)	2 (4.8%)	0.584
Cerebrovascular accident	0 (0%)	1 (6.7%)	1 (2.4%)	0.357

**Fisher's exact test was used for all comparisons*

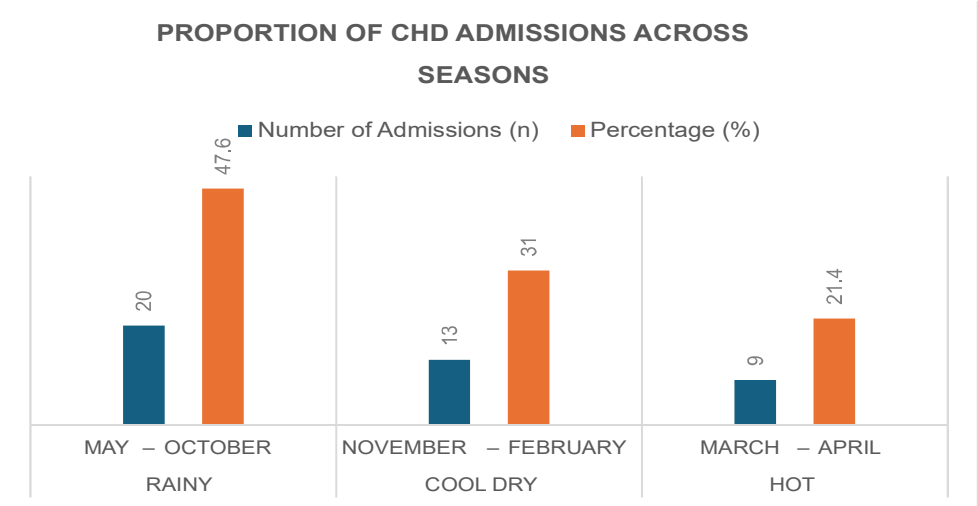


Figure 1: Seasonal Variation of Admissions

Seasonal Variation of Admissions

CHD admissions showed seasonal variation (Figure 1). Of the 42 cases, 20 (47.6%) occurred during the rainy season (May-October), 13 (31.0%) during the dry season (November-February), and 9 (21.4%) during the hot season (March-April). This pattern aligns with overall EPU admission trends reported previously.[13]

Management and Outcomes

Medical management: All 42 children received medical therapy: antibiotics (35, 83.3%), oxygen (26, 61.9%), diuretics (21, 50.0%), digoxin (10, 23.8%), and iron/folate (18, 42.9%). Hypoxic spells were managed with knee-chest position, morphine, oxygen, and propranolol.

Surgical referral: Only 3 (7.1%) children accessed surgical referral. One underwent surgery (VSD closure) in Southern Nigeria; 2 were awaiting surgery at the time of data collection. The remaining 39 (92.9%) did not access surgical care due to financial constraints (32, 82.1%), lack of referral centres within the country (4, 10.3%), or caregiver refusal (3, 7.7%).

Hospital stay: Median duration was 8 days (IQR: 4-15). Sixteen (38.1%) stayed <7 days, 19 (45.2%) 7-14 days, and 7 (16.7%) >14 days. Prolonged stay was associated with complications (p=0.004) and the need for intensive care (p=0.002).

Outcomes: Of 42 children, 24 (57.1%) were discharged home on medical therapy, 15 (35.7%) died during admission, 2 (4.8%) were discharged against medical advice (DAMA), and 1 (2.4%) absconded. Among 15 deaths, 12 (80.0%) occurred in infants, and 10 (66.7%) in children with complex cyanotic CHD.

Documented causes of death included refractory heart failure (7, 46.7%), severe pneumonia with respiratory failure (4, 26.7%), hypoxic spells (2, 13.3%), and sepsis (2, 13.3%).

Follow-up: Of 24 discharged children, only 9 (37.5%) returned for at least one follow-up visit; 15 (62.5%) were lost to follow-up. Median follow-up duration among returnees was 2 months (IQR: 1-5).

Factors Associated with Mortality

Univariate analysis identified factors significantly associated with mortality (Table 5). Multivariate logistic regression (Table 6) revealed independent predictors: age <6 months (AOR: 3.41, 95%CI: 1.38-8.42, p=0.008), delayed presentation (AOR: 2.89, 95%CI: 1.18-7.06, p=0.021), heart failure at presentation (AOR: 3.92, 95%CI: 1.54-9.97, p=0.004), complex CHD (AOR: 4.56, 95%CI: 1.72-12.08, p=0.002), and lack of surgical referral (AOR: 7.23, 95%CI: 1.51-34.62, p=0.013). The final multivariate model demonstrated good fit (Hosmer-Lemeshow test: χ^2=6.23, df=8, p=0.621; Nagelkerke R^2=0.487).

Table 5: Univariate Analysis of Factors Associated with Mortality

Variable	Died (n=15)	Survived (n=27)	OR (95% CI)	p-value
Age at presentation				
<6 months	10 (66.7%)	8 (29.6%)	4.22 (1.89-9.41)	0.001
≥6 months	5 (33.3%)	19 (70.4%)	Reference	
Gender				
Male	8 (53.3%)	15 (55.6%)	0.92 (0.41-2.06)	0.842
Female	7 (46.7%)	12 (44.4%)	Reference	
Delayed presentation				
Yes (>6 months)	12 (80.0%)	14 (51.9%)	3.71 (1.56-8.83)	0.003
No	3 (20.0%)	13 (48.1%)	Reference	
Heart failure at presentation				
Present	11 (73.3%)	10 (37.0%)	4.68 (2.01-10.89)	<0.001
Absent	4 (26.7%)	17 (63.0%)	Reference	
CHD type				
Cyanotic	10 (66.7%)	5 (18.5%)	3.82 (1.67-8.74)	0.001
Acyanotic	5 (33.3%)	22 (81.5%)	Reference	
Complex CHD				
Yes	12 (80.0%)	6 (22.2%)	6.12 (2.58-14.53)	<0.001
No	3 (20.0%)	21 (77.8%)	Reference	
Pulmonary hypertension				
Present	8 (53.3%)	7 (25.9%)	3.02 (1.31-6.96)	0.009
Absent	7 (46.7%)	20 (74.1%)	Reference	
Surgical referral				
No	14 (93.3%)	25 (92.6%)	9.33 (1.89-46.12)	0.006
Yes	1 (6.7%)	2 (7.4%)	Reference	

Table 6: Multivariate Logistic Regression - Independent Predictors of Mortality

Table 6: Multivariate Logistic Regression - Independent Predictors of Mortality

Variable	Adjusted OR (95% CI)	p-value
Age <6 months	3.41 (1.38-8.42)	0.008
Delayed presentation	2.89 (1.18-7.06)	0.021
Heart failure at presentation	3.92 (1.54-9.97)	0.004
Complex CHD	4.56 (1.72-12.08)	0.002
Lack of surgical referral	7.23 (1.51-34.62)	0.013

Hosmer-Lemeshow goodness-of-fit: χ^2=6.23, df=8, p=0.621; Nagelkerke R^2=0.487

Discussion

This one-year study provides contemporary data on the burden of congenital heart disease among children presenting to an emergency paediatric unit in North-Eastern Nigeria. The hospital-based proportion of 1.41% among 2,973 admissions aligns with reports from Lagos (1.4%)[16] and Benin City (1.6%).[17] The slightly higher proportion in this cohort may reflect improved case detection following the introduction of regular paediatric echocardiography services in September 2023. Notably, while CHD constituted only 1.41% of admissions, it accounted for 4.8% of all deaths (15 of 310 total deaths) in the EPU during 2024, confirming that CHD carries a disproportionately high death risk (3.4 times the overall mortality rate) compared to other childhood illnesses in this setting.

The median presentation age of 9 months, with 69.0% being infants, mirrors findings from Ibadan[18] and Kano[19] where most CHD presents in the first year of life. However, this represents a significant diagnostic delay (median 6 months from symptom onset) compared to high-income countries, where prenatal diagnosis and neonatal screening enable detection within weeks of birth.[20] Delayed presentation occurred in 61.9% of our cohort, higher than the 32% reported in a South African study[21] but consistent with other Nigerian reports.[22-24]

The predominance of children from rural areas (76.2%) and caregivers without formal education (54.8%) highlights socio-demographic factors that may contribute to delayed diagnosis and poor outcomes, though formal association testing with mortality was limited by sample size. Late CHD presentation has been documented in Cameroon[25] and Ethiopia.[26] Community-based health education targeting rural populations could improve early recognition of CHD symptoms such as difficulty feeding, tachypnoea, and cyanosis.

Ventricular septal defect (33.3%) was the commonest lesion, consistent with global[27] and Nigerian epidemiological data.[7,9,28] The high proportion of symptomatic VSDs likely reflects the fact that moderate-to-large defects present early with heart failure and recurrent infections, making them more likely to be diagnosed in hospital settings.[29]

Tetralogy of Fallot (21.4%) was the predominant cyanotic lesion, similar to reports from Ibadan (19.8%) [30] and Lagos (22.3%) [31]. The relatively high TOF proportion may reflect survival beyond infancy without intervention, with progressive cyanosis eventually bringing children to medical attention. In contrast, duct-dependent lesions like TGA and pulmonary atresia often result in early death without detection, potentially leading to under-representation in hospital-based studies.[32]

The proportion of complex CHD (42.9%) exceeds figures from some other Nigerian centres[18] but is comparable to reports from other Sub-Saharan African countries.[33] This high proportion may reflect referral bias; children with complex lesions are more likely to be symptomatic and reach tertiary care, while those with simple lesions may remain undiagnosed in the community. The 11.9% prevalence of associated extracardiac anomalies, particularly Down syndrome (4.8%), underscores the importance of CHD screening in children with dysmorphic features.[34]

The high frequency of respiratory difficulty (78.6%), recurrent infections (54.8%), and failure to thrive (47.6%) reflects the haemodynamic consequences of CHD. Left-to-right shunts produce pulmonary overcirculation, leading to tachypnoea and recurrent chest infections, while cyanotic lesions cause chronic hypoxaemia, impairing growth.[35]

Heart failure at presentation in 50.0% of children is concerning but consistent with Nigerian studies: Ekure et al.[31] reported 52% in Lagos, and Ogunbiyi et al.[18] found 41-48% in Ibadan. Heart failure in infants with CHD carries high mortality without timely intervention[36] and its high prevalence in our study reflects delayed diagnosis and limited treatment access.

The 14.3% incidence of hypoxic spells among cyanotic CHD patients is comparable to 12-18% reported elsewhere.[37] Hypoxic spells are emergencies requiring immediate intervention and are associated with increased morbidity if poorly managed.[38] The cerebrovascular accident in one TOF patient highlights thromboembolic risks in cyanotic CHD, particularly with iron deficiency and dehydration.[39]

The finding that 47.6% of CHD admissions occurred during the rainy season (May-October) aligns with the overall EPU admission pattern reported by Yusuf et al. [13], where 43.5% of total admissions occurred during this period. This seasonal clustering may reflect increased respiratory infections during the rains, which precipitate heart failure in children with underlying CHD.

The 35.7% mortality rate is distressingly high, but mirrors reports from other Nigerian centres without cardiac surgery facilities such as Ibadan (31%)[18] and Kano (36%).[19] These figures contrast sharply with <5% mortality in high-income countries, where early diagnosis and prompt surgical intervention are standard.[40]

The independent mortality predictors identified, i.e., age <6 months, delayed presentation, heart failure, complex CHD, and lack of surgical referral provide actionable targets for intervention. Infants under 6 months had 3.4-fold higher mortality odds, reflecting vulnerability during the transitional circulation period.[41]

The strongest predictor of mortality was lack of surgical referral (AOR: 7.23). Only 7.1% of children accessed surgical care, a stark illustration of the treatment gap in Nigeria, where fewer than 10 centres offer paediatric cardiac surgery for over 200 million people.[42] Financial constraints (82.1% of non-referred cases) were the predominant barrier, as most families cannot afford the out-of-pocket costs of surgery abroad. Similar challenges are reported across Sub-Saharan Africa.[43,44]

Given the delayed presentation, limited diagnostic capacity, and poor access to definitive treatment observed in this study, training primary healthcare workers to recognise early signs of congenital heart disease and implementing routine newborn pulse oximetry screening[45] could reduce diagnostic delays. Strengthening echocardiography services, expanding basic echocardiography training for paediatricians, and establishing telemedicine links[46] with paediatric cardiology centres would improve diagnostic capacity and facilitate timely referral. To address the severe treatment gap, regional cardiac surgical centres with coordinated referral pathways[47] should be developed, and paediatric cardiac surgery should be included in the National Health Insurance benefit package to

lessen the financial burden[49] that prevented 82% of families from accessing surgery. International partnerships and charitable collaborations[50] remain important to expand surgical volumes while local capacity is being built.

Some limitations must be acknowledged. This was a single-centre, retrospective study of only 42 patients with 15 deaths, limiting generalisability and the stability of multivariate estimates; the identified predictors should be regarded as exploratory. Neonates were excluded and follow-up was short, so the full spectrum and long-term outcomes of CHD are not captured. Selection bias toward severe, hospitalised cases probably overestimates complication and mortality rates. The small sample precluded adjustment for important confounders such as nutritional status. Multi-centre prospective studies with larger cohorts are needed to validate these findings.

Conclusion

Congenital heart diseases significantly contribute to paediatric morbidity and mortality in Azare, North-Eastern Nigeria, accounting for 1.41% of admissions and 4.8% of deaths in 2024, with a case fatality rate of 35.7%. Infants are primarily affected, often presenting late with complications including heart failure and pneumonia, while access to surgical care is extremely limited (7.1%). Independent mortality predictors include age under six months, delayed presentation, heart failure at presentation, complex CHD, and lack of surgical referral. To meet SDG 3.2 targets, Nigeria must enhance early detection, diagnostic capacity, and financial protections for affected families. This study's data aims to inform policy and resource allocation for paediatric cardiac services in underserved regions.

Conflict of Interest: None

Author's contribution: BAI, MOY, SOB, and FB conceptualised and designed the study. BAI, MOY, SP, and LIA were responsible for data acquisition and clinical management. BAI, SOB, and FB performed the data analysis and interpretation. BAI drafted the manuscript. All authors critically revised the manuscript for important intellectual content, approved the final version, and agreed to be accountable for all aspects of the work.

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