ORIGINAL ARTICLE

Audit of Cardiac Disorders in Children at the University of Maiduguri Teaching Hospital: A 5-Year Retrospective Review

Ibrahim BA,[1,2,3] Bukar MA,[3] Wala SI,[3] Farouk AG,[3] Pius S,[3] Talle MA.[4]

ABSTRACT

Background: Paediatric cardiac disorders contribute substantially to childhood morbidity and mortality in sub-Saharan Africa. Due to protracted conflict and economic deprivation, northeastern Nigeria remains without a cardiac surgical facility. **Aim:** To describe the spectrum, clinical characteristics, and outcomes of childhood cardiac disorders at the University of Maiduguri Teaching Hospital, the principal referral centre for Nigeria's North-East region. **Methods**: We conducted a five-year (2016–2020) retrospective audit of all children aged 0–15 years with echocardiography-confirmed cardiac disorders. Data were extracted from clinic registers, echocardiogram logs, and case notes. Outcomes assessed included mortality, loss to follow-up, and surgical referral. **Results:** Of 287 children, 189 (65.9%) had congenital heart disease (CHD) and 98 (34.1%) acquired disease. Median age at presentation was 3.5 years (IQR 1.2–7.0). Among CHD, acyanotic lesions predominated (141, 74.6%), with ventricular septal defect the commonest lesion (62, 32.8%), followed by patent ductus arteriosus (35, 18.5%) and tetralogy of Fallot (27, 14.3%). Rheumatic heart disease (RHD) comprised 81.6% of acquired cases and 27.9% of all cases; 57 (71.3%) of children with RHD presented with moderate or severe valvular damage, followed by pericardial effusion (9, 9.2%). Overall, 179 (62.4%) of children presented more than six months after symptom onset, and the median diagnostic delay was 14 months. Only 28 (9.8%) children were referred for cardiac surgery—all out-of-country—and just eight (2.8% of the total cohort) underwent operation, primarily due to prohibitive costs. Nineteen children (6.6%) died, nearly half of them infants with complex CHD and 29 (14.3%) were lost to follow-up. **Conclusion:** Children with heart disease in Northeastern Nigeria present late with advanced stages of preventable conditions and face insurmountable barriers to surgical care. We recommend register-based RHD control programmes, investment in local echocardiography capacity, and a regional strategy to make cardiac surgery accessible.

Key words: Congenital heart disease, rheumatic heart disease, paediatric cardiology, global health, sub-Saharan Africa, health services research, health equity.

[1]Department of Paediatrics, Federal University of Health Sciences, Azare, Bauchi State, Nigeria, [2]Department of Paediatrics, Federal University of Health Sciences Teaching Hospital, Azare, Nigeria,[3]Department of Paediatrics, University of Maiduguri Teaching Hospital, Maiduguri, Borno State, Nigeria. [4]Department of Internal Medicine, University of Maiduguri Teaching Hospital, Maiduguri, Borno State, Nigeria

Corresponding Author:

Dr Bello Abdullahi Ibrahim
Department of Paediatrics, Federal University of Health Sciences Teaching Hospital, Azare, Bauchi State, Nigeria,
Email: bello.ibrahim@fuhsa.edu.ng Tel: +2348036477149

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Introduction

Cardiac disorders in children encompass a wide spectrum of conditions, from simple holes between heart chambers to complex diseases and malformations that are incompatible with life without intervention. Congenital heart disease (CHD) affects approximately 8–10 per 1,000 live births globally, making it the most common group of congenital anomalies. [1,2]

Acquired heart disease—predominantly rheumatic heart disease (RHD)—adds to this burden, particularly in low-income settings where poverty, overcrowding, and limited access to healthcare allow a preventable complication of streptococcal sore throat to

become a leading cause of cardiovascular death in young people. [3]

The global epidemiology of paediatric heart disease reflects profound inequities. In high-income countries, the RHD that once filled hospital wards has virtually disappeared, and CHD is managed through well-established networks of prenatal diagnosis, neonatal intervention, and lifelong follow-up.[4] In sub-Saharan Africa, by contrast, RHD remains endemic, affecting 2–3% of school-age children in some communities,[5] and CHD goes largely undiagnosed or diagnosed too late for optimal intervention.[6] The region bears an estimated 15% of the global RHD burden while having access to only 0.2% of the world's cardiac surgical workforce. [7,8]

Nigeria exemplifies these contrasts. As Africa's most populous nation, with over 200 million people, it has made progress in some areas of child health—under-five mortality has declined from 201 per 1,000 live births in 2003 to 117 per 1,000 in 2023. [9] But this national average mask enormous regional disparities. The North-East region, where this study was conducted, consistently lags behind the south on every health indicator: higher poverty rates, lower literacy, worse vaccination coverage, and poorer access to healthcare. [9]

Studies from southern Nigeria have documented the spectrum of paediatric heart disease reasonably well. Community-based echocardiographic screening in Lagos found a CHD prevalence of 6.6 per 1,000 schoolchildren, with ventricular septal defect (VSD) being the most common lesion. [10] Hospital-based studies from Asaba, Enugu, and Benin City have described similar patterns. [11–13] But these findings cannot simply be extrapolated to the north. The North-East differs not just demographically but also epidemiologically. The region has higher rates of poverty and malnutrition, which may affect both the incidence of RHD and the presentation of CHD. The region has also been devastated by a more than a decade-long insurgency that has destroyed health facilities and displaced millions. [14] It has no cardiac surgical centre whatsoever.

The University of Maiduguri Teaching Hospital (UMTH) serves as the main tertiary referral centre for the entire North-East region, receiving patients from Borno, Yobe, Adamawa, Taraba, and Gombe States, with a catchment population of approximately 20 million people. Yet, in its role as a referral centre, there are no published data on the burden and outcomes of paediatric cardiac disease at UMTH.

This audit was undertaken to fill that gap. The aim of the study was to determine the pattern of presentation, and outcome of the children with heart disease seen at UMTH over five years, 2016 to 2020.

Methods

Study design and setting

The study was a retrospective, hospital-based audit at the UMTH, Maiduguri, Borno State, Nigeria. UMTH is a 1,560-bed tertiary facility and the leading teaching hospital serving Nigeria's entire North-East geopolitical zone. Paediatric cardiology services at UMTH are provided within the Department of Paediatrics. During the study period (2016–2020), the department had one consultant paediatric cardiologist and two resident doctors with an interest in cardiology. A single echocardiography machine served the entire paediatric population. Cardiac surgery was not available at UMTH or anywhere else in Northeastern Nigeria; children requiring surgical intervention were referred to centres in southern Nigeria (Lagos, Ibadan) or abroad (primarily India), usually at their families' own expense.

Study population

We included all children aged 0–15 years with a confirmed diagnosis of a cardiac disorder (congenital or acquired) seen at UMTH between 1 January 2016 and 31 December 2020.

Inclusion criteria:

Age 0–15 years at diagnosis

Echocardiography-confirmed cardiac diagnosis

Available medical records with complete demographic and diagnostic information

Exclusion criteria:

Patients with alternative diagnoses

Case ascertainment and data collection

Cases were identified from a variety of sources to ensure the most comprehensive capture:

Paediatric cardiology clinic registers

Echocardiogram request logs and report books

Paediatric medical ward admission records

Individual patient case notes

A structured data abstraction form was developed and piloted on 20 cases, with minor modifications made for clarity. Two research assistants collected data under the supervision of the lead investigator (BAI). Data were double-entered into a Microsoft Excel database, with 10% of records randomly selected for verification by a second investigator; discrepancies were resolved by consensus.

Data extracted included the following:

Demographic characteristics and Referral source (self, primary health centre, general hospital, private clinic), Clinical characteristics, Cardiac diagnosis, and Outcome data (as of 31 December 2020). This includes:

Vital status (alive, deceased)

Loss to follow-up (defined as no clinic attendance for >12 months)

Referral for cardiac surgery

Place of referral (within Nigeria, abroad)

Surgical outcome if known

Echocardiography

All diagnoses were confirmed by transthoracic echocardiography performed by the consultant paediatric cardiologist or senior residents under direct supervision. During the study period, the consultant cardiologist reviewed 100% of studies performed by residents; there were no disagreements on major diagnostic findings. All children who followed up for 14 months were included in the study. Studies were performed using a Sonoscape S8 cardiac ultrasound machine with paediatric cardiac probes (5–8 MHz). Standard parasternal long-axis, parasternal short-axis, apical four-chamber, subcostal, and suprasternal views were obtained. Doppler and colour flow mapping were used to assess haemodynamic significance and severity of regurgitation. [15] CHD lesions were classified according to standard nomenclature. RHD was diagnosed according to the 2012 World Heart Federation echocardiographic criteria. [15] Echocardiographic images were not archived in a format permitting re-analysis using the 2023 criteria

For the purpose of this study, Delayed presentation has been defined as more than six months between symptom onset and diagnosis. [16]

Data analysis

Data was analysed using IBM SPSS Statistics for Windows, Version 23.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were computed for all variables. Categorical variables were summarised as frequencies and percentages. Continuous variables were assessed for normality using the Shapiro-Wilk test and visual inspection of histograms; none were normally distributed, so we present medians with interquartile ranges (IQR).

Categorical variables were compared between groups using Pearson's χ^2 test or Fisher's exact test as appropriate. All tests were two-tailed, and $p < 0.05$ was considered statistically significant.

Ethical considerations

The Health Research Ethics Committee of the University of Maiduguri Teaching Hospital approved the study (Ref: UMTH/REC/2021/042). Given the retrospective design and use of anonymised data, individual patient consent was waived. All data were handled confidentially and stored on password-protected computers accessible only to the research team.

Results

Over the five-year study period, 312 children with suspected cardiac disorders were identified. After excluding 25 with incomplete records or unconfirmed diagnoses, 287 children formed the final cohort. These 287 children came from 51 local government areas across five states—Borno, Yobe, Adamawa, Taraba, and Gombe.

The number of diagnosed cases increased gradually over the study period, from 48 in 2016 to 71 in 2020—a 48% rise (Figure 1).

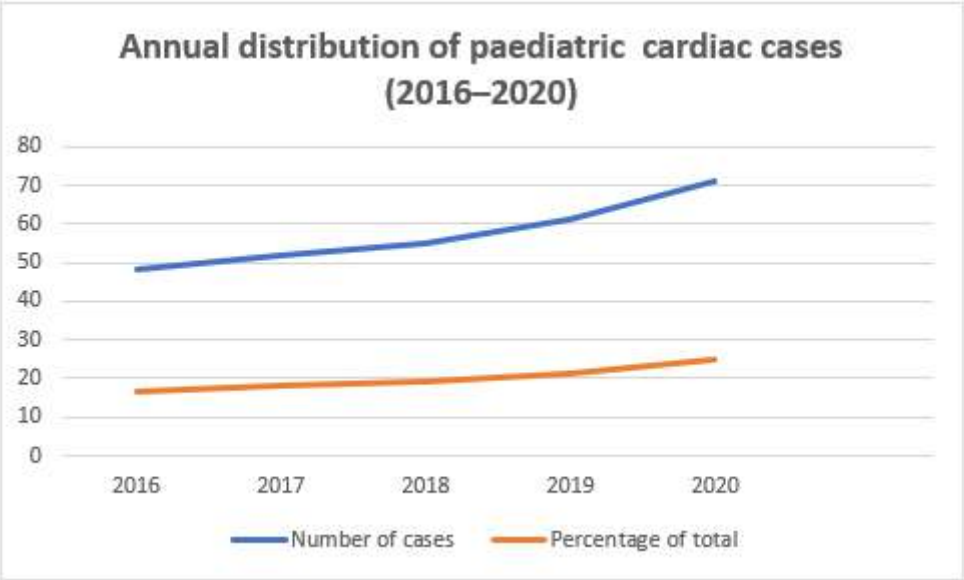

Figure 1: Annual distribution of cardiac cases (2016–2020)

The median age at presentation was 3.5 years (IQR 1.2–7.0 years), but this masked a wide range, from a 2-day-old neonate with transposition of the great arteries to a 15-year-old with end-stage rheumatic mitral regurgitation. Infants under one year accounted for 22.6% (n=65), children aged 1–5 years for 38.7% (n=111), and those over five years for 38.7% (n=111) (see Table 1). There was a slight male predominance: 151 boys (52.6%) and 136 girls (47.4%), giving a male-to-female ratio of 1.1:1.

Most children (n=211, 73.5%) were referred from other health facilities: primary health centres (n=81, 28.2%), general hospitals (n=102, 35.5%), or private clinics (n=28, 9.8%). Direct presentations from home accounted for 76 (26.5%) presentations. The majority (82.9%, n=238) resided in Borno State, with the remaining 49 (17.1%) from neighbouring states.

Table 1: Demographic characteristics of the 287 children

Characteristic	Category	Number	Percentage
Age group	<1 year	65	22.6
	1–5 years	111	38.7
	>5–15 years	111	38.7
Sex	Male	151	52.6
	Female	136	47.4
Referral source	Self-referred	76	26.5
	Primary Health Centre	81	28.2
	General Hospital	102	35.5
	Private Clinic	28	9.8
State of origin	Borno	238	82.9
	Yobe	28	9.8
	Adamawa	15	5.2
	Gombe	6	2.1

Note: No patients from Taraba State

The spectrum of cardiac disorders

Of the 287 children, 189 (65.9%) had CHDs, and 98 (34.1%) had AHD.

Congenital heart disease

Among the 189 CHD cases, acyanotic lesions predominated, accounting for 74.6% (n=141). Ventricular septal defect (VSD) was the single most common lesion, seen in 62 children (32.8% of all CHD). These were not all small, haemodynamically insignificant defects; many had large shunts, with 31% already showing signs of pulmonary hypertension at diagnosis. Patent ductus arteriosus (PDA) followed, with 35 cases (18.5%), with female predominance (female: male ratio 2.5:1). Atrial septal defect (ASD) accounted for 28 cases (14.8%), as shown in Table 2.

Cyanotic CHD comprised 48 (25.4%) cases. Tetralogy of Fallot (TOF) was the most frequent cyanotic lesion, seen in 27 children (14.3% of all CHD). The median age at presentation for TOF was 2.8 years (IQR 1.5–4.5), and nearly half (44.4%) had already experienced hypercyanotic ("tet") spells before diagnosis. Transposition of the great arteries (TGA) was diagnosed in eight infants, all within the first week of life, but all too late for the arterial switch to be feasible. Multiple cardiac lesions were present in 44 (23.3%) patients. The most common combinations were VSD + PDA (n=14) and VSD + ASD (n=11). These children tended to present earlier, with more severe symptoms; their complex anatomy made management even more challenging.

Table 2: Spectrum of congenital heart disease (n=189)

LESION TYPE	NUMBER	PERCENTAGE
Acyanotic CHD	**141**	**74.6**
Ventricular Septal Defect (VSD)	62	32.8
Patent Ductus Arteriosus (PDA)	35	18.5
Atrial Septal Defect (ASD)	28	14.8
Pulmonary Stenosis	9	4.8
Coarctation of Aorta	4	2.1
Aortic Stenosis	3	1.6
Cyanotic CHD	**48**	**25.4**
Tetralogy of Fallot	27	14.3
Transposition of Great Arteries	8	4.2
Tricuspid Atresia	5	2.6
Pulmonary Atresia	4	2.1
Ebstein's Anomaly	2	1.1
Double Outlet Right Ventricle	2	1.1
Total	**189**	**100.0**

Syndromic associations

Down syndrome (trisomy 21) was clinically diagnosed in 19 children; 10.1% of all CHD cases and 65.5% of those with identified syndromes. All the children with clinically suspected trisomy 21 had either atrioventricular septal defects (10, 5.3%) or large VSDs (9, 4.8%). The true prevalence of genetic syndromes is almost certainly higher; we lacked the capacity for karyotyping or chromosomal microarray, so subtle syndromic features may have been missed.

Rheumatic heart disease

Table 3 shows the characteristics of the 80 children with RHD seen over the five years. These constitute 81.6% of AHD and 27.9% of all cardiac cases. These children were older, with a median age of 10.5 years (IQR 8.0–13.0), and there was a slight female predominance (female: male ratio 1.2:1). Only 15% had a documented history of acute rheumatic fever; for the remainder, RHD was the first indication that anything was wrong. The median delay between symptom onset and diagnosis was 14 months (IQR 6–24 months). At diagnosis, 71.3% already had moderate or severe valvular lesions.

Table 3: Characteristics of children with rheumatic heart disease (n=80)

Characteristic	Category	Number	Percentage
Age group	5–9 years	34	42.5
	10–15 years	46	57.5
Sex	Male	36	45.0
	Female	44	55.0
History of acute rheumatic fever	Yes, documented	40	50.0
	No	40	50.0
Severity of regurgitation at presentation	Mild	23	28.7
	Moderate	35	43.8
	Severe	22	27.5

The mitral valve was the most affected, involved in 73 cases (91.3%). Isolated mitral regurgitation was the most common pattern (38.8%), followed by combined mitral and aortic regurgitation (22.5%). Mixed mitral valve disease (stenosis and regurgitation) was observed in 15.0% of cases. Only six children (7.5%) had isolated aortic valve involvement (Table 4).

Table 4: Pattern of valvular involvement in RHD (n=80)

VALVE INVOLVEMENT	NUMBER	PERCENTAGE
Isolated Mitral Regurgitation	31	38.8
Mitral + Aortic Regurgitation	18	22.5
Mixed Mitral Valve Disease	12	15.0
Mitral Stenosis	8	10.0
Isolated Aortic Regurgitation	5	6.2
Mitral Regurgitation + Aortic Stenosis	4	5.0
Tricuspid Regurgitation (functional)	2	2.5
Total	**80**	**100.0**

Complications at diagnosis were common; 25 (31.3%) had echocardiographic evidence of pulmonary hypertension, 31 (38.8%) were in heart failure, and 4 (5.0%) had atrial fibrillation. Only 12 (15%) were receiving secondary prophylaxis with monthly benzathine penicillin.

Delayed presentation was recorded in 179 (62.4%) of all children. For CHD, the median delay was 6 months (IQR 2–15 months), and for RHD, it was more than twice as long: 14 months (IQR 6–24 months; p<0.001).

Who was most likely to present late? Children from rural areas (71.3% delayed vs 48.6% from urban; p<0.001). Children referred through primary health centres (68.9% delayed vs 51.2% of self-referrals; p=0.008). Children whose caregivers had no formal education (73.5% delayed vs 54.2%; p=0.002). And for RHD, those without a recalled history of acute rheumatic fever (78.9% delayed vs 45.2%; p=0.001).

Other acquired heart diseases

The prevalence of other acquired heart diseases was relatively low. These include pericardial effusion (9, 9.2%) and acute myocarditis (5, 5.1%). Note that Myocarditis was diagnosed based on echocardiographic features, but was not confirmed histologically.

Outcomes:

Outcomes data for these children showed they received care for a median of 14 months (IQR 4–28 months). Their outcomes are summarised in Table 5.

Table 5: Outcomes of children with cardiac disorders (n=287)

OUTCOME	CHD (N=189)	ACQUIRED (N=98)	TOTAL (N=287)
Alive and in follow-up	108 (57.1%)	61 (62.2%)	169 (58.9%)
Lost to follow-up	29 (15.3%)	12 (12.2%)	41 (14.3%)
Referred for surgery	22 (11.6%)	6 (6.1%)	28 (9.8%)
Died	14 (7.4%)	5 (5.1%)	19 (6.6%)
Discharged (lesion closed/resolved)	16 (8.5%)	14 (14.3%)	30 (10.5%)

The 'Discharged' category includes children with spontaneous closure (CHD) or full recovery (acquired) who were no longer considered to require active follow-up. These children are not included in the 'Alive and in follow-up' count.

Mortality: Nineteen children (6.6%) died during follow-up. Nine of these deaths (47.4%) were infants with complex CHD—TGA, pulmonary atresia, large VSDs with refractory heart failure. Five deaths (26.3%) were from RHD, all in adolescents with severe mitral regurgitation and end-stage heart failure. One child died from infective endocarditis complicating RHD.

Loss to follow-up: Forty-one children (14.3%) disappeared from our records. We do not know what happened to them. Where reasons were documented, financial constraints topped the list (n=18), followed by transportation difficulties (n=12).

Surgical referral: Only 28 children (9.8%) were ever referred for cardiac surgery—22 with CHD (mostly TOF, VSD with pulmonary hypertension, and TGA) and 6 with severe RHD. All referrals were out-of-country (India 26, Egypt 2). There were no active cardiac surgeries in the country during the audit period. There was no closer option. Of these 28, only 8 (28.6%) underwent surgery; the rest could not afford it (n=15), were lost to follow-up (n=3), or died while awaiting arrangements (n=2). Among the 8 who made it to surgery, 6 had successful outcomes, 1 (TOF) died post-operatively while at home, and 1 was lost to follow-up after returning to Nigeria (See Table 5).

The most clinically significant finding of this audit is the near-total absence of surgical care. Only one in ten children was even referred for surgery. Of those, fewer than one in three underwent an operation. The rest—children with potentially correctable lesions - progress to develop complications or to die.

Spontaneous improvement: Sixteen children with CHD (8.5%)—all with small muscular VSDs or tiny PDAs—were discharged after documented

spontaneous closure. Fourteen children with acquired disease (14.3%) recovered fully—those with pericardial effusion (9, 9.2%) and acute myocarditis (5, 5.1%, as well as other transient conditions (e.g., acute heart failure).

Discussion

This audit lifts the veil on some aspects of paediatric cardiac disease in northeastern Nigeria. Over five years, 287 children with confirmed heart disease were seen.

The spectrum of disease we observed—65.9% CHD, 34.1% acquired, with VSD leading the CHD list and RHD dominating acquired cases—is broadly similar to reports from other Nigerian centres. [10–13] This consistency suggests that the underlying epidemiology of paediatric heart disease in Nigeria is reasonably well understood. What distinguishes our findings is not the types of lesions we saw, but what happened to the children who had them.

A dominant theme of this audit is delay at multiple levels—recognising symptoms, seeking care, reaching diagnostic facilities, obtaining echocardiography, and referral. Consequently, most children presented with advanced disease: 71% of RHD cases had moderate or severe valvular damage, 31% of VSDs had pulmonary hypertension, and nearly half of TOF patients had experienced cyanotic spells. [16-17]

At the primary care level, health workers lack training in basic cardiac assessment. A heart murmur may go unnoticed, or if noticed, may be dismissed as innocent without proper evaluation. There is no pulse oximetry to detect hypoxaemia. There are no protocols for when to refer.

At the referral level, the journey to diagnosis is long. For a child in a remote village in Yobe State, reaching UMTH may require a 12-hour journey on unpaved roads, costing more than a month's income. Once at the hospital, they join a queue for the then region's single echocardiography machine. The wait can be weeks.

The fact that very few children underwent surgery was purely economic. Cardiac surgery in India costs $6,000–$10,000—an impossible sum to raise for families in a region where 70% of the population lives on less than $2 per day.[18] The National Health Insurance Scheme, such as it is, does not cover overseas surgery. There are no charitable foundations systematically supporting such referrals. Families sell land, livestock, and everything they own, and still fall short of raising the amount needed. The absence of local surgical capacity is a scandal. Nigeria has a handful of centres performing a limited range of paediatric cardiac surgery—in Lagos, Ibadan, and a few other cities—but none in the North-East. The distance from Maiduguri to Lagos is 1,500 kilometres. For a sick child with a heart lesion, that journey is impossible. And even if they could reach Lagos, the cost would still be high for most. **These limitations underscore the importance of prevention, particularly for conditions such as rheumatic heart disease that are largely avoidable.**

The 80 children with RHD in this audit represent missed prevention opportunities. RHD is a disease of poverty, caused by inadequate treatment of streptococcal pharyngitis. It is also a disease for which the prevention is known. Register-based control programmes, combining echocardiographic screening with secondary prophylaxis, have dramatically reduced RHD burden in Cuba, in some Pacific Island nations, and in parts of Africa.[19,20] In Uganda, the Ugandan RHD Registry now follows thousands of children on monthly penicillin, with demonstrated reductions in disease progression.[21-22] In our setting, we have none of this, in a formal way. Most children are diagnosed too late for secondary prophylaxis to be very useful, and the valve damage is already significant. Only 15% were receiving penicillin at diagnosis, and even those were unlikely to continue, given the challenges of monthly injections and the lack of a registry to track them.

The reasons for loss to follow-up are the same as those causing delayed presentation: poverty, distance, and lack of understanding of the disease's chronicity. This is compounded by a lack of a system for patient tracking, community health workers following up on defaulters, and transport subsidies. This is in addition to a lack of functional insurance system that covers the entire population.

The limitations of this study include its hospital-based design, use of retrospective data, and the study period (2016–2020), which coincided with the Boko Haram insurgency in Borno State, likely affecting healthcare access and outcomes in ways our data cannot capture. There was also a lack of capacity for genetic testing, so syndromic CHD is almost certainly underdiagnosed. Finally, follow-up was relatively short (median 14 months), so longer-term outcomes—

including surgical outcomes for those referred abroad—are incomplete.

Conclusions

This audit demonstrates significant inequities in outcomes for children with congenital and acquired heart disease in our setting. Children born with lesions identical to those seen in high-resource settings face substantially worse outcomes, not because of biological differences, but due to systemic gaps in diagnosis, referral, access to intervention, and peri-operative care. With targeted, modest investments such as subsidised diagnostics, a coordinated referral network, task-shifting for echocardiography screening, and a regional surgical partnership, the identified gaps can be addressed.

Recommendations

1. Establish a regional RHD control programme. This should include school-based echocardiographic screening to detect subclinical disease, enrolment of affected children in a register, and systematic delivery of monthly benzathine penicillin through decentralised clinics.
2. Invest in echocardiography capacity. One machine for 20 million people is absurd. We need additional machines not just at UMTH, but also at strategic secondary and other tertiary facilities across the region. We need training programmes for doctors and cardiac nurses in basic and advanced echocardiography. Task-shifting—training non-physicians to perform screening echocardiography.
3. Train primary care workers to recognise heart disease.
4. Develop a regional surgical strategy. In the long term, Northeastern Nigeria needs its own cardiac surgical centre.
5. Reduce loss to follow-up. This means decentralising follow-up care: training local health workers to monitor children on penicillin, check for complications, and provide support.

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Data availability: The anonymised data can be made available upon reasonable request.

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