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Original Research Article

Right Bundle Branch Block and Associated Structural Cardiac Abnormalities among School Children in Kathmandu

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ABSTRACT:

Introduction: Right bundle branch block (RBBB) is a conduction abnormality well-described in adults, but its prevalence and clinical significance in children remain poorly understood, particularly in Nepal. This study aimed to determine the prevalence of RBBB among school children in Kathmandu and assess associated structural cardiac abnormalities by echocardiography. **Methods**: A school-based descriptive cross-sectional study was conducted among 160 students (grades 6–10) in Kathmandu, Nepal, from July to December 2025. Participants underwent clinical examination and 12-lead electrocardiography. Children with RBBB underwent transthoracic echocardiography. Data were analyzed using PSPP version 2.1.1, with $p<0.05$ considered statistically significant. **Results**: RBBB was identified in 10 children (6.25%), predominantly incomplete (n=9, 5.63%), while complete RBBB was rare (n=1, 0.62%). There were no significant differences in age, gender distribution, or electrocardiographic parameters (PR interval, QTc interval, QRS duration) between children with and without RBBB. Echocardiography was normal in seven children (70%). Structural abnormalities were observed in three children (30%): mild mitral regurgitation with mitral valve prolapse in two (20%, both with incomplete RBBB) and a large secundum atrial septal defect with right ventricular dilatation in one (10%, the child with complete RBBB). **Conclusions**: RBBB was uncommon among school children, with incomplete RBBB predominating. Although most children with RBBB had normal echocardiograms, structural abnormalities were identified in a small number of cases. These echocardiographic findings are exploratory and hypothesis-generating, requiring confirmation in larger, adequately powered studies.

Keywords: Echocardiography; Electrocardiography; Right Bundle Branch Block; School children.

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INTRODUCTION

Right bundle branch block (RBBB) is an electrocardiographic (ECG) abnormality of delayed right ventricular depolarization due to impaired conduction in the right branch of the His-Purkinje system.[1] Complete right bundle branch block (CRBBB) is one of the most common intraventricular conduction disorders identified in pediatric electrocardiogram (ECG) evaluations. According to the American Heart Association (AHA), American College of Cardiology (ACCF), Heart Rhythm Society (HRS) Expert Consensus, complete RBBB is defined as a QRS duration of ≥120 ms with an rsr′, rsR′, or rSR′ pattern in leads V1–V2 and a broad S wave (>40 ms) in leads I and V6. Incomplete RBBB

is diagnosed in children when the QRS duration is 90–100 ms (or 80–90 ms for children aged <8 years), with the same rsr′ morphology and broad S wave criteria.[2]

Though RBBB is extensively reported in adults, its prevalence and clinical relevance in children remain underreported. RBBB in children can take place after surgery for congenital heart defects such as atrioventricular canal defects, ventricular septal defect (VSD), Ebstein's anomaly or tetralogy of Fallot.[3,4] However, the presence of isolated CRBBB in children without structural heart disease is generally considered benign, although data on this subject are limited, and most studies have focused on patient groups who have undergone surgery or have underlying cardiac pathology.[5,6] In the absence of any history of surgery or structural anomalies, RBBB is normally considered benign, though recent evidence suggests its potential association with future cardiovascular risk.[7,8]

In the developing countries like Nepal, routine ECGs are being applied more widely in pediatric screening and school health evaluation. Incidental RBBB is thus frequently encountered by clinicians with no agreement on its meaning or on the need for further studies. Local prevalence data and structural correlations do not exist. This study aims to measure the prevalence of RBBB in school-going children in Kathmandu and evaluate the presence of any structural heart disease on echocardiogram. The results are expected to enhance diagnostic yield, reduce unnecessary referrals, and provide a foundation for additional studies on pediatric cardiac conduction abnormalities in Nepal.

METHODS

This school based descriptive cross-sectional study was conducted in a secondary high school located in Kathmandu, Nepal from July 2025 to December 2025. The school is a private, co-educational institution serving a middle-income urban population in Kathmandu with half of its students coming from rural Nepal on scholarship. Approval was taken from the institutional review committee (Ref. 21072025/22) prior to the study.

A study published in the International Journal of Pediatric Research estimated the prevalence of RBBB in apparently healthy school-going children was approximately 10%.[3] Based on it, with a 10% prevalence of RBBB, a 95% confidence interval, and a 5% margin of error, the number required to be sampled would be 139 children. To accommodate potential non-responses and technical mistakes in recording ECG, we suggest sampling 150 children or more.

All students in Grades 6–10 present on the day of screening were included. Students with a history of cardiac surgery, myocarditis, or acute rheumatic fever, and those with any previously diagnosed congenital heart disease were excluded from the study. Detailed information and instructions of this study regarding the aims, objectives, purpose, expected outcomes and ultimate benefits was clearly explained to each parent and informed written consent was taken, along with verbal assent from each participating student.

Demographic details were collected on a pre-designed proforma and following a thorough general examination by a pediatrician a standard 12-lead ECG was performed by a trained doctor using a portable BPL Cardiart 6208 View Plus 3-channel ECG machine. The ECGs were taken using a paper speed of 25mm/sec and filter settings of AC 50 Hz, EMG 35 Hz with a baseline drift of 0.1 HZ and those with artifact were repeated. Two cardiologists interpreted the ECGs for consensus of ECG findings.[9] All children found to have RBBB underwent transthoracic echocardiography for evaluation of structural abnormality by the same cardiologist at a tertiary care center. Echocardiography was done using Samsung V8 model with a phased-array cardiac 5S/5Sc probe and standard views of parasternal long-axis (PLAX), parasternal short-axis (PSAX), apical 4-chamber (A4C), apical-5-chamber (A5C) probe and subcostal 4-chamber (SC4C) in 2D, M-mode, color and spectral Doppler (PW/CW).

Data was manually verified for accuracy, entered into a computer, and descriptive analysis was carried out by frequency and percentage for categorical variables. Continuous variables were presented as mean ± SD. Chi-square test was used to test the statistical significance of cross-tabulation between categorical variables. Independent t-test was used to compare mean ± SD of continuous variables between two groups. P value < 0.05 was considered statistically significant. PSPP version 2.1.1 was used for statistical analysis.

RESULTS

A total of 160 children were clinically examined along with ECGs recording and evaluation. RBBB was detected in 6.25% (n=10), predominantly incomplete (n=9, 5.63%), while complete RBBB was rare (n=1, 0.62%). RBBB was not detected in

150 (93.75%) participants.

The mean age of the study population (n=160) was 13.97 ± 1.52 years, with 59.37% (95) aged 10–14 years and 40.62% (65) aged 15-18 years. There was a majority of Males (88, 55%) compared to Females (72, 45%).

ECG parameters of the participants is presented in **Table 1**. The mean PR interval was 143.59 ms, QTc interval 399.11 ms, and QRS duration 97.51 ms. The intervals were not significantly associated with RBBB.

Relationship between baseline characteristics and RBBB are presented in **Table 2**. There was no significant difference in mean age between those with and without RBBB. RBBB was higher among individuals aged 15-18 years compared to 10-14 years. Similarly, RBBB was higher among males compared to females, but these differences were not statistically significant.

Echocardiographic examination revealed normal findings in 70% (7/10) of the children who had RBBB. Various pathologies were detected in the remaining children. Two children (20%) had a combination of mild mitral regurgitation (MR) and mitral valve prolapse (MVP), both were from the incomplete RBBB. The remaining one (10%) child had a large secundum atrial septal defect (ASD) with right ventricular dilation and was the one with complete RBBB.

Table 1*: ECG parameters of the participants (n=160)**

ECG Parameter	Overall (n=160), Mean (SD)	RBBB (n=10), Mean (SD)	No RBBB (n=150), Mean (SD)	Statistics
PR interval (ms)	143.59 (15.18)	135.00 (18.34)	144.17 (14.84)	t=-1.85, p=0.06
QTc interval (ms)	399.11 (35.89)	399.50 (19.00)	399.09 (36.78)	t=0.03, p=0.97
QRS duration (ms)	97.51 (29.00)	103.90 (18.31)	97.09 (29.57)	t=0.71, p=0.47

**Statistical comparisons should be interpreted with caution due to the small sample size of the RBBB subgroup (n=10). The study was powered for the primary objective of estimating RBBB prevalence, not for subgroup comparisons. Therefore, these inferential statistics are exploratory and may be underpowered to detect meaningful differences.*

Table 2*: Association between baseline characteristics and RBBB*

Variables	RBBB		Statistic
	Yes	No	
Age (years), Mean ± SD	14.6 ± 1.51	13.93 ± 1.52	t=1.35, p=0.16
Age group, n (%)			
10 to 14 years (n=95)	4 (4.2%)	91 (95.8%)	χ^2=0.91, p=0.34
15 to 18 years (n=65)	6 (9.2%)	59 (90.8%)	
Gender, n (%)			
Male (n=88)	8 (9.1%)	80 (90.9%)	χ^2=1.72, p=0.189
Female (n=72)	2 (2.8%)	70 (97.2%)	

DISCUSSION

In the present study, RBBB was identified in 6.25% of school-aged children aged 10-18 years, with incomplete RBBB accounting for the majority of cases. This finding suggests that RBBB, particularly the incomplete form, is not uncommon among apparently healthy school children undergoing routine ECG screening. According to some studies, RBBB, although typically benign, has been suggested to, in some cases, reflect the presence of underlying cardiac disease and thus require investigation using echocardiography.[9] The predominance of incomplete RBBB is consistent with its relatively frequent occurrence in pediatric populations and may reflect age-related variation in right ventricular conduction rather than clinically significant cardiac disease.

To our knowledge, no published Nepalese data exist on the prevalence of RBBB in healthy school-aged children or its association with structural cardiac malformations. This lack of data can lead to either over-investigation or under-detection of significant cardiac disease. Local baseline data are essential for evidence-based decision-making, reducing unnecessary family distress, and guiding appropriate referrals. This study provides the first such epidemiological data from Nepal.

The predominance of incomplete RBBB (5.63%) over complete RBBB (0.62%) in our cohort is consistent with the understanding that incomplete RBBB is a common normal variant in children. Although RBBB appeared more frequent in males and in the 15-18 years age group, these differences were not statistically significant, likely due to the limited number of RBBB cases. Echocardiographically, 70% of children with RBBB had normal findings, while 30% had structural abnormalities, including one case of ASD with right ventricular dilation.

The identification of structural abnormalities on echocardiography in 30% of children with RBBB in our study warrants attention. Although most children with RBBB had normal echocardiographic findings, the detection of a large secundum atrial

septal defect with right ventricular dilatation in one child highlights that complete RBBB may occasionally be associated with clinically relevant structural heart disease. The finding of mitral valve prolapse with mild mitral regurgitation in two children further emphasizes the importance of interpreting an abnormal ECG in conjunction with clinical assessment rather than considering RBBB in isolation. In settings such as Nepal, where local pediatric ECG data are limited, these findings support a selective approach to further cardiac evaluation of children with RBBB, particularly when accompanied by clinical findings or other ECG abnormalities.

The association between CRBBB and ASD has been reported numerous times previously.[5,10-12] A study by MacLachlan et al. reported that atrial septal defect (ASD) was identified in 57% of young patients presenting with complete right bundle branch block (CRBBB), and that a prolonged QRS duration (≥130 ms) along with additional electrocardiographic abnormalities was associated with a higher likelihood of underlying pathology.[13] In our series, QRS duration did not differ significantly between children with and without RBBB. This finding is not surprising, as most cases in our cohort were incomplete RBBB, which typically produces only modest QRS prolongation, unlike complete RBBB, which is defined by a QRS duration ≥120 ms.

Previous studies suggest that RBBB, particularly CRBBB, is linked to increased cardiovascular mortality in adults.[5,12,14] In contrast, this relationship is less well established and remains uncertain in the pediatric population.[10-12] Our findings indicate that pediatric RBBB is largely benign in its course, but is associated with structural cardiac pathology in approximately one-third of cases. Therefore, echocardiographic evaluation is recommended, especially in the presence of a wide QRS duration, additional ECG anomalies, or clinical suspicion.

The relatively large standard deviation of QRS duration (97.51 ± 29 ms) indicates considerable variability within the study population. This variability is expected given the inclusion of children both with and without RBBB, as RBBB is characterized by delayed right ventricular conduction and consequently a longer QRS duration. The observed dispersion may therefore reflect differences in QRS duration between children with normal conduction and those with RBBB rather than measurement variability alone. Although the distribution may suggest separation between these groups, further analysis using a larger sample would be required to confirm the distributional pattern.

Limitations

This study has several limitations. First, the sample size was calculated specifically to estimate the prevalence of RBBB and was not powered to assess the prevalence or determinants of structural cardiac abnormalities among children with RBBB. Only 10 participants were identified as having RBBB, of whom three had echocardiographic abnormalities. Therefore, the echocardiographic findings should be interpreted with considerable caution and are exploratory and hypothesis-generating rather than confirmatory. Second, as a cross-sectional investigation conducted at a single school in Kathmandu, the findings may not be broadly generalizable to the wider Nepalese pediatric population or to other settings. Third, the absence of long-term follow-up prevents evaluation of whether RBBB may progress to more severe conduction abnormalities, arrhythmias, or other complications. Fourth, echocardiography was performed by one of the cardiologists who interpreted the ECGs; therefore, the echocardiographer was not blinded to the ECG findings, which may introduce observer bias. Additionally, echocardiography was performed only in children with RBBB, so we cannot determine whether the prevalence of MR/MVP or ASD differs from the general pediatric population without RBBB.

CONCLUSIONS

RBBB was relatively uncommon among the school children studied, with incomplete RBBB being the predominant pattern. Although RBBB was more frequent among males and adolescents aged 15-18 years, these associations were not statistically significant. Most children with RBBB had normal echocardiographic findings, while structural abnormalities were identified in a small number of cases. These echocardiographic findings were exploratory and hypothesis-generating and should not be interpreted as evidence of an association between RBBB and structural heart disease. Larger, adequately powered studies are needed to clarify the clinical significance of pediatric RBBB and determine which children may benefit from further cardiac evaluation.

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