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# Prevalence of Rheumatic Heart Disease Detected by Echocardiographic Screening Among School Children in the Niger Delta Region of Nigeria

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## Abstract

Rheumatic heart disease (RHD) is an important public health problem in developing countries. Community-based studies using portable echocardiography have enhanced detection of RHD for early intervention. The aim of this study was to determine the prevalence of RHD among school children in Port Harcourt, the pattern of valvular involvement (s), the relationship of RHD with certain risk factors (such as overcrowding and socioeconomic status) and to ascertain the sensitivity, specificity and positive predictive value of cardiac auscultation in detecting RHD. A total of 461 students aged 5-15 years were selected by multi-staged sampling from thirteen schools in Port Harcourt. Questionnaires were used to obtain relevant information on history suggestive of rheumatic fever or RHD and parents' occupation and level of education. Subsequently, all the selected students had cardiac auscultation and echocardiographic examination. Ethical clearance was obtained from the Research and Ethics Committee of the University of Port Harcourt Teaching Hospital and from Rivers State Ethical Committee. The study revealed an RHD prevalence rate of 4.3 per 1,000 students using cardiac auscultation and 6.5 per 1,000 students using echocardiography only. All (100%) of the affected students with RHD were within the age category of 11-15 years and were females. Mitral regurgitation (66.7%) was the commonest valvular lesion seen. There was significant association between RHD and overcrowding ($p = 0.04$), while 66.7% belonged to the middle socioeconomic class (SEC) and 33.3% to the low SEC. Cardiac auscultation is 66.7% sensitive and 98.7% specific in detecting RHD with a positive predictive value of 25% when compared with echocardiography. This study shows that RHD is a problem among school children within the study area. It is recommended that community screening of children for RHD using echocardiography for early detection and treatment should be undertaken to advert complications and improve the quality of life of the affected individuals.

## Keywords

Rheumatic Heart Disease, Prevalence, Echocardiography, Screening

## 1. Introduction

Rheumatic heart disease (RHD) is a chronic consequence of acute rheumatic fever (ARF), which is a sequelae of Group A β haemolytic streptococcal (GAβHS) infection of the tonsillo-pharynx, resulting in immune mediated inflammatory reactions that involve many body organs including the heart, joints, skin and central nervous system. [1] Rheumatic heart disease is often the outcome of repeated ARF infections. [1, 2] Although RHD is now rare in developed countries, it remains a public health problem and a common cause of chronic heart disease in children and young adults in developing countries, especially in sub-Saharan Africa. [2-5]

The economic consequences of the disease both in health related costs and indirect costs as a result of repeated

hospitalisations, huge resources needed for medical and surgical treatments and suffering caused to the affected children and their relatives, impact significantly on the individual, family and the society at large. [1, 5, 6] Morbidity from RHD is also substantial, with an estimated 6.6 million disability adjusted life-years (DALYs) lost to RHD worldwide each year. [3] Affected children particularly suffer from chronic ill health, psychological problems, and poor school performance due to recurrent school absenteeism as a result of the illness. [1, 6, 7]

Studies have shown that developing countries in Africa, Southeast Asia, Central and South America are the most affected because the epidemiologic determinants of the disease such as overcrowding, poverty, illiteracy and inadequate access to health care are still rife in these regions. [1, 8-13] As these countries constitute 80% of the world's population, the implications of the disease burden cannot be overlooked. [14] Nigeria, being the most populous country in Africa, is likely to account for a large proportion of cases of RHD. [6]

In developing countries, prevalence of RHD ranges from 6.9 to 36.5 per 1,000 school children. [8, 9] In Nigeria, an estimated prevalence of 7.8 to 9.8% have been reported in hospital-based studies. [15, 16] However, a comparatively lower prevalence of 0.5 to 0.7 per 1,000 populations is seen in developed countries, and this has been attributed to improved socioeconomic status, better housing and enhanced living conditions. [5, 17]

Rheumatic heart disease is preventable through early diagnosis and adequate treatment of GAβHS infection of the tonsillo-pharynx. [1] Even when already existing, early detection of RHD can result in interventions to halt the progression of cardiac damage. This early detection can be done by targeted clinical history and cardiac auscultation for the presence of murmurs. [1] Although history taking and cardiac auscultation are important in the evaluation of children with suspected RHD, recent advances in non-invasive echocardiographic technique which is now reasonably available in developing countries has improved the diagnosis of RHD and the characterisation of valvular involvements. [1, 8, 11, 13] This has been demonstrated in recent population-based studies that included surveys in Africa especially among children, where modern portable echocardiography has provided the opportunity for enhanced detection of children with RHD for intervention. [11, 13, 18, 19]

Over the years, different international consensuses on diagnostic modality and echocardiographic criteria for RHD have been developed, among which are the World Health Organisation (WHO) criteria,[1] the Joint WHO and the United States National Institutes of Health (NIH) criteria,[20] the "Combined criteria" proposed by Marijon et al [21] and the World Heart Federation (WHF) criteria. [22] Of these, the WHO criteria1 is comparatively simple and feasible for population screening especially in resource poor countries like Nigeria.

In Nigeria, existing reports on the prevalence of RHD are mostly hospital-based and retrospective, which may not be representative of the true burden of the disease. Hospital-based prevalence of RHD of 7.8% and 9.8% respectively has been reported by Danbauchi et al [15] in Zaria and Sani et al [16] in Kano. A school screening for RHD in Lagos forty years ago by Ogunbi et al [23] gave a prevalence of 0.08 per 1,000 school children. Recent comparative community-based studies on the burden of RHD are scarce and no recent study has been done in Niger-Delta region of Nigeria of which Port Harcourt is a part.

This study sought to address this by undertaking a community-based cross-sectional survey on the prevalence of RHD detected by echocardiographic screening of school age children in Port Harcourt Local Government Area (PHALGA) of Rivers State, Nigeria. If RHD is found to be prevalent, it may suggest the need to incorporate cardiac screening examination into school entry medical examination under the existing School Health Programme in the country and commencement of secondary prophylaxis for cases detected.

## 2. Materials and Methods

This study was carried out in Port Harcourt Local Government Area (PHALGA), which is one of the 23 local government areas in Rivers State. Rivers State is located in Southern Nigeria within its Niger-Delta region. The urban nature of the area, oil exploration and production activities have caused a great influx of people from other parts of Rivers State and Nigeria as well as many foreign Nationals which has caused overcrowding and proliferation of urban slums locally referred to as 'Batchers'. The study population were children aged 5-15 years in public and private primary and secondary schools in PHALGA. Data obtained from Rivers State Ministry of Education showed that as at 2012/2013 academic session, there were a total of 140 primary schools and 55 secondary schools in PHALGA. Inclusion criteria included; children 5 - 15 years in the selected schools and whose parents / guardians gave written consent while exclusion criteria included; children < 5 and >15 years in the selected schools, children whose parents/ guardians did not consent to the study, children who were absent on study days and children with known congenital heart disease before onset of the study. This study is a cross-sectional survey and multi-staged sampling technique was used to select the subjects from selected schools. Based on the sample size of 461 and 13 selected schools (7 primary and 6 secondary schools), an average of 36 subjects were recruited from each selected school.

### 2.1. Ethical Consideration

Ethical clearance was obtained from the Research and Ethics Committee of University of Port Harcourt Teaching Hospital (UPTH) and from Rivers State Ethical Committee. Notification and permission to carry out the study was obtained from Rivers State Ministry of Education. Also, written informed consent was obtained from the parents or guardians of selected students. The children diagnosed with RHD were referred to the paediatric cardiologist at the UPTH for management.

### 2.2. Study Procedure

The study was conducted over an eight month period

(September 2014 to April 2015) by a team comprising of two paediatric cardiologists and a paediatric cardiology senior resident doctor. Questionnaires were used to obtain relevant information on history suggestive of rheumatic fever or RHD and parents' occupation and level of education. Subsequently, all the selected students had cardiac auscultation and echocardiographic examination.

#### 2.2.1. Cardiac Auscultation

All selected students had cardiac auscultation with particular attention paid to the presence of apical pansystolic murmur that radiates to the axilla which suggests the presence of mitral regurgitation, or early diastolic murmur of aortic regurgitation.

#### 2.2.2. Echocardiographic Examination

Echocardiographic examination was performed on all recruited students at a pre-scheduled time by the paediatric cardiologist in the schools using a portable ultrasound sound system (Sonosite Macromaxx, 3.5 MHz transducer). Multiple cross-sectional views were taken from long and short parasternal axis, subcostal and apical four chamber views noting valve morphology on cross-sectional two-dimensional imaging and the degree and extent of mitral and aortic regurgitation using pulsed and continuous wave and colour flow Doppler. [1, 20, 24] The structure of the intracardiac valves particularly the mitral and aortic valves were evaluated with respect to the presence of thickening and deformity such as the elbow or bent knee appearance of the mitral valve leaflets. The evidence of valvular incompetence or stenosis was noted. Where there was regurgitation, the length and peak velocity of the regurgitant jet were measured. Children with valvular regurgitation had their echocardiography videos/clips stored on the machine and later reviewed by the Paediatric cardiologists as a team for validation of diagnosis. The diagnosis of RHD was made according to the WHO echocardiographic criteria: [1]

Evidence of mitral- or aortic-valve regurgitation seen in two planes;

A regurgitant jet > 1cm in length;

A mosaic colour jet with a peak velocity > 2.5 m/s;

Doppler colour jet persists throughout systole (for mitral valve) and diastole (for aortic valve).

Children with heart murmur consistent with mitral regurgitation and/or aortic regurgitation and in whom RHD was confirmed echocardiographically were classified as having clinically detected RHD while children without murmur but echocardiographic evidence of RHD were classified as having subclinical RHD.

### 2.3. Socioeconomic Stratification and Overcrowding

This was done based on the classification described by Oyedeji. [25] All children living in households with more than 2.5 persons per room were classed as living in overcrowded homes. [26] In this instance, any child younger than 10 years within a household was regarded as a child and given a score of 0.5; while any person ten years and above was given a score of 1. [26]

Parents/guardians of the students with clinical and/or echocardiographic evidence of RHD were counselled and referred to UPTH for further evaluation and intervention which included; immediate commencement of antibiotic prophylaxis, repeat echocardiography clinical review and surgical treatment where clinically indicated.

### 2.4 Data Analysis

Data was analysed using the Statistical Package for Social Science (SPSS) version 20.0. Data are presented as charts and tables. Comparison of sub-groups was carried out using chi square test, Student's t-test and Fisher's exact test as appropriate. Statistical significance at 95% confidence interval was $p < 0.05$. Sensitivity, specificity and positive predictive value of cardiac auscultation (with cardiac murmur as a sign) in detecting RHD using echocardiography as standard was calculated using the software Medcalc.

## 3. Results

### 3.1. Age and Sex Distribution of the Study Group

The age range is from 5 to 15 years with a mean age of 10.29±2.77 years and median of 11 years. Male to female ratio is 1: 1.2. The mean age of the males was 11.30±2.917 years while that of their female counterparts was 11.24±2.920 years. The mean age of the students in public schools was 10.59±3.074 years while that of the private schools was 10.51±2.675 years.

### 3.2. Prevalence of Rheumatic Heart Disease and Valvular Involvement

Among the 461 students examined, 2 had rheumatic heart disease using cardiac auscultation (with apical pan systolic murmur) giving a prevalence of 4.3 per 1,000 school children. Using echocardiography alone on the same group (461 students), three students were diagnosed with RHD giving a prevalence of 6.5 per 1,000 school children. The three (100%) students diagnosed with RHD were all within the age category of 11-15 years and were females. Age-specific prevalence of RHD for children aged 11-15 years in the study group was 1.3% while sex-specific prevalence for females in the study subjects was 1.2%. All (100%) the children with RHD had mitral regurgitation. Isolated mitral regurgitation was the commonest and seen in 66.7% of the cases identified. Regurgitation was severe in two (66.7%) of the subjects with mitral regurgitation. The regurgitant jet length of the mitral regurgitations ranged from 12mm to 33mm while the peak velocity (Vmax) was between 260cm/s to 360cm/s. There were morphologic changes on all the affected valves consisting of valvular thickening. All (100%) of the students with RHD live in overcrowded homes. There was significant difference in the occurrence of RHD among children that live in overcrowded homes and those that do not (p=0.041).

There was no significant difference in the socioeconomic status of students with and without RHD (P=0.801). Two (66.7%) of the students with RHD where in middle socioeconomic class while 1 (33.3%) was in the lower socioeconomic class.

### 3.3. Sensitivity, Specificity & PPV of Cardiac Auscultation in Detecting RHD

Cardiac auscultation (using murmur as a sign) is 66.7% sensitive and 98.7% specific in detecting RHD with a positive predictive value (PPV) of 25% when compared to echocardiography which is the gold standard which had a sensitivity of 92.3%, specificity and PPV of 98.7 and 66.7% respectively.

### 3.4. Characteristics of the Subjects with Rheumatic Heart Disease

Table 1 shows an overview of the characteristics of the subjects with RHD.

***Table 1.*** *Characteristics of the Subjects with Rheumatic Heart Disease.*

| | Age (Yrs) | Gender | SEC | Overcrowding | Symptom | Cardiac auscultation (Murmur) |
|---|---|---|---|---|---|---|
| Case 1 | 11 | F | Middle | Yes | None | None |
| Case 2 | 13 | F | Low | Yes | Recurrent sore throat, easy fatiguability | Apical pansystolic murmur radiating to the axilla |
| Case 3 | 14 | F | Middle | Yes | Previously diagnosed with RHD | Apical pansystolic murmur radiating to the axilla |

***Table 1.*** *Continued.*

| | Echocardiographic findings |
|---|---|
| Case 1 | Pathological mitral regurgitation (regurgitant jet length of 12mm, peak velocity of 260.01cm/s, regurgitation seen in two planes). |
| Case 2 | Pathological mitral and aortic regurgitations (for mitral valve; regurgitant jet length of 33mm, peak velocity of 360cm/s, regurgitation seen in two planes. For aortic regurgitation; regurgitant jet length of 21mm, peak velocity of 240.7cm/s, regurgitation seen in two planes. |
| Case 3 | Pathological mitral regurgitation (regurgitant jet length of 23mm, peak velocity of 336.47cm/s, regurgitation seen in two planes). |

SEC-Socioeconomic Class, RHD-Rheumatic Heart Disease.

## 4. Discussion

This study found the prevalence of RHD using echocardiography to be 6.5 per 1,000 school children. This prevalence is higher than the prevalence of 0.08 per 1,000 children reported by Ogunbi et al [23] in Lagos possibly due to the different screening tools used. Ogunbi et al [23] used the less sensitive cardiac auscultation alone for screening. It is also plausible that the difference in the ages of children screened between the two studies may contribute to the variations in the result observed. While this study was conducted on children aged 5-15years, Ogunbi et al [23] on the contrary, studied children between ages 6-12 years.

In studies by Longo-Mbenza et al [11] in Kinshasa and Beaton et al [13] in Uganda a higher prevalence of 14.03 per 1,000 children and 14.8 per 1,000 children respectively were reported among school children aged 5-16 years using both cardiac auscultation and echocardiography. The higher prevalence found in Kinshasa and Uganda compared to this present study could in part be due to the variation in the sample sizes employed as 4,848 and 4,869 school children were studied respectively while this present study was on 461 school children. In addition, it is plausible that the difference in the result obtained could be a reflection of the prevalent poor socioeconomic circumstances in those countries at the time of the study. The relatively higher values in the studies by Longo-Mbenza et al [11] and Beaton et al [13] were attributed largely to overcrowded living conditions and poor socioeconomic background of the children studied.

In contrast to the prevalence of RHD found in this study, Saddiq et al [19] in Pakistan and Ba-Saddik et al [8] in Yemen reported higher prevalence rates of RHD of 21.9 per 1,000 and 36.5 per 1,000 school children respectively in children aged 5-15 years. The relatively lower prevalence reported in this present study could possibly be because, the study was carried out in an urban setting with somewhat improved access to healthcare and improvement in sanitation occasioned by the recurring environmental sanitation programmes that take place within the state and community where this study was done. This might explain the wide variation in the prevalence of RHD reported.

Furthermore, this study demonstrated that echocardiographic screening is superior to cardiac auscultation in the detection of RHD as reflected in the prevalence rates of 4.3 per 1,000 children using cardiac auscultation and 6.5 per 1,000 school children using echocardiography alone. Similar findings have been reported by Saxena et al [27] and Rama et al [41] both in India. This might be a reflection of the lower sensitivity of cardiac auscultation in detecting children with mild valvulitis. [21]

All (100%) children diagnosed with RHD in this study were females. This is similar to what has been previously reported by Ba-Saddik et al [8] in Yemen, where females were more affected than their male counterparts. The reason for this predilection for females is generally unknown but some studies have attributed it to behavioural patterns in females who are more often housebound and having closer involvement in child care and living in poorly aerated rooms, thus more likely to have exposure to GABHS infections and overcrowding. [28, 29]

All (100%) of the cases of RHD found in this study were also within the age category of 11-15 years which is similar to reports in Pakistan [19] and Yemem [8], where a higher prevalence of RHD was demonstrated in 10-16 years age group. This is not surprising because chronic valvular

involvement takes time to develop following an acute attack of RF at a younger age. This underscores need for early detection for intervention such as secondary prophylaxis with penicillin to stop progression of valvulitis and further worsening of the condition.

Mitral incompetence with regurgitation was the most common type of RHD lesion seen in the study group (66.7%). This is not surprising as the mitral valve has been variously reported to be the commonest valve involvement in RHD. [8, 9, 11, 19, 23] Mixed valvular involvement was observed in 33.3% cases of RHD seen in this study, with mitral and aortic regurgitations co-existing. This is higher than what was reported by Ba-saddik et al [8] in Yemen (as seen in 17.8% of cases) and Saddiq et al[19] in Pakistan (as demonstrated in 8% of cases) but not farfetched from what Bode-Thomas et al [30] in Nigeria (40%) found among children with RHD. In children, combined mitral and aortic valve involvement often leads to rapid progression of disease and severe haemodynamic compromise with increasing age. [25, 31] No case of mitral stenosis was seen in this study, possibly because MS takes years to develop after the attack of ARF and as such is seen more commonly in adults who are not included in this present study.

All 3 (100%) of students with RHD lived in overcrowded rooms and as such were at risk for the disease. Similar findings have been previously reported among school children in Pakistan [19] and Yemen [8] with 100% and 64.8% of children respectively found with RHD living in overcrowded households. Overcrowding tends to propagate the spread of GABHS, the organism implicated in RF and RHD. Interestingly, it is important to note that sensitivity of overcrowding in this study as a predictor of occurrence of RHD was 100%, thus overcrowding is a major factor predisposing to RHD. Increased urbanisation has been suggested as a factor associated with overcrowding as individuals move from rural areas to urban areas for the purpose of seeking for jobs. There is need for multifaceted approach that should include development of culturally appropriate health promotion programmes regarding hygiene practices and also improved infrastructure and housing projects that requires government support.

With regards to socioeconomic status, majority (66.7%) of the students with RHD in this survey were from middle socioeconomic class while 33.3% belonged to the low socioeconomic class. None was from the high socioeconomic class. This could be because a considerable number (47%) of the students screened in this present study are from middle socioeconomic class. The rapid population growth in Port Harcourt being an oil city in Nigeria where a lot of graduates come in to acquire jobs has produced overcrowding as housing in Port Harcourt are very expensive leading to many homes having to accommodate family, relatives and friends who are yet to settle in with a job. This may ultimately promote the spread of GABHS with resultant RHD if there is no timely detection and intervention.

This study compared the use of cardiac auscultation for murmur as a screening tool for RHD, with that of echocardiography which is the "gold standard"; and found that cardiac auscultation has moderate sensitivity of 66.7% and a low positive predictive value of 25%. This finding implies that though cardiac auscultation can detect RHD in some children, it is not very reliable as 30% of affected individuals can be missed. This is further compounded by the poor PPV of cardiac auscultation such that the presence of a murmur cannot predict the presence of RHD in 75% of the population screened. This is especially true for subclinical cases where valvular damage exist without overt clinical signs and symptoms. This highlights the superiority of echocardiography as a reliable screening tool that can detect such subclinical cases for prompt intervention. Similar findings have been observed by Marijon et al [18] among school children in Cambodia and Mozambique with cardiac auscultation missing 90% of children with abnormal echocardiogram. Comparatively, Carapetis et al [32] in Tonga demonstrated a poor sensitivity of cardiac auscultation in detecting children with RHD.

The findings from this study also demonstrated that 98.7% of children without cardiac murmurs are negative and do not have RHD. This implies that cardiac auscultation is more likely to exclude the presence of RHD in children. This finding has been observed in a study by Carapetis et al [32] in Tonga and further highlights the superiority of echocardiography over cardiac auscultation for case detection of RHD.

Echocardiography as a screening tool for RHD tends to have high sensitivity and specificity which help to minimize the number of missed cases of RHD. This was demonstrated in this study as echocardiography had a high sensitivity and specificity of 92.3% and 99.8% respectively. It is therefore not surprising that more cases of RHD are detected with this technology than auscultation alone. It is thus recommended that echocardiography be done routinely for the diagnosis of patients with RHD as clinical examination alone can miss various lesions, especially when the lesions are mild or when multiple lesions are present.

Most (66.7%) of the students with RHD in this study were diagnosed for the first time and unaware of their condition, thus were not receiving penicillin prophylaxis for preventing recurrent episodes of RF which may cause their condition to deteriorate. Other studies in Pakistan and Yemen among school children reported a similar pattern. [8, 19] This may be as a result of the fact that some children with RHD were either not symptomatic or ignorant of the condition. A low awareness of RHD could impact on expression of the disease and impose a heavy burden of disabling condition on children and adolescents. This calls for attention to the need to identify these children with RHD early and follow them up with penicillin prophylaxis and regular evaluation of the state of the affected valves.

Although this study has provided some indication of the burden of RHD within this locality, it is possible that the prevalence of RHD may have been underestimated since only children who were present in school were sampled and so might have missed students with significant long-standing or

severe illness. These sick children may have been absent from school because of severity of the illness or are even likely to have dropped out of school.

## 5. Conclusion

The prevalence of RHD in this study is higher than what was previously reported among school children in Nigeria. There is a need for early identification of children with RHD so that penicillin prophylaxis can be commenced, thus preventing recurrence of RF and progression of cardiac valve lesions. Echocardiographic screening is a feasible means to detect these cases for intervention.

## Conflict of Interest

The authors declare that they have no competing interest.

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