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# Ventricular Septal Defects among Children in Lagos

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***Authors' contributions***

*This work was carried out in collaboration between all authors. Author BAA designed the study, wrote the protocol and wrote the first draft of the manuscript. Author ADMW managed the literature searches, performed the analysis. Author OG managed the experimental process. Author BAA supervised the overall write up. All authors read and approved the final manuscript.*

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## ABSTRACT

**Background:** Although the incidence of Ventricular Septal Defects (VSD) has been reported in other reports on Congenital Heart Disease (CHD) in the region. None has considered VSD as a separate entity. Other previous studies on Congenital Heart Disease in the region had also been for a short period of time (at best two years) with fewer sample sizes hence the need for this study which aims to document the prevalence and clinical profile of children with VSD in a busy tertiary hospital in Sub-Saharan Africa using data collected over nine years.
**Methods:** Prospective and cross sectional involving consecutive patients diagnosed with ventricular septal defect using clinical evaluation and echocardiography at the Paediatric Department of Lagos State University Teaching Hospital, Lagos Nigeria as part of a large study between January 2007 and December 2015.
**Results:** Ventricular septal defect was diagnosed in 352 patients, out of which 157 had isolated VSD while 195 had VSD associated with other heart defects (excluding Tetralogy of Fallot). Male to female ratio was 1.1:1. The children were aged 4 days to 13 years, with a mean of 25.18±37.41

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months and the median age of eight (8) months. The prevalence of all VSDs in the study population was 10.7 per 10,000 children, and isolated VSD was 4.7 per 10,000 children. The prevalence of VSD amongst other congenital heart diseases was 31.1 and 13.9% for all VSDs and isolated VSDs respectively. Atrial Septal Defects (ASD) were the most common associated acyanotic congenital heart defects followed by Patent Ductus Arteriosus (PDA). Double Outlet Right Ventricle (DORV) was the most common associated cyanotic congenital heart disease. Perimembranous VSD was the most common followed by the sub-aortic type.

**Conclusion:** Ventricular Septal Defects is as common in Nigeria as in the other parts of the world. The most common associated defect was Atrial septal defects and the most common type is perimembranous.

*Keywords: Children; Lagos; congenital; heart; disease.*

## 1. INTRODUCTION

Ventricular septal defect (VSD) is a clinical condition characterized by connections or opening between both ventricles. It is the most common congenital heart disease in children [1,2]. It accounts for up to 50% of all CHD and an incidence of 1.56 to 53.2 per 1,000 live birth [3]. Reported prevalence in Nigerian children is 27.6 to 55% of all congenital heart lesions [4-8].

VSD occurs as an isolated defect or in association with other intracardiac lesions [9]. There are various classifications of VSD [9]. A simple classification proposed by Soto et al. [10] in 1980 based on the phenotypic location of the defects is commonly employed. There are four major categories which include: Perimembranous defects with subcategories such as inlet, trabecular and infundibular; muscular defects with subcategories of the inlet, trabecular or infundibular; sub-arterial defects (also referred to as Conal septal, subpulmonic, sub-arterial doubly committed defects) and lastly the mixed variety consisting of one or more combinations.

The aetiology of VSD is unknown. A combination of genetic and environmental influences has been postulated. Common risk factors identified includes; maternal diabetes with poorly controlled diabetes in pregnancy, infants of mothers with poorly controlled elevated phenylalanine levels, maternal alcohol consumption during pregnancy and the occurrence of a family history of a cardiac defect [11]. VSD is also associated with chromosomal anomalies such as the trisomy, 13 (Patau syndrome), 18 (Edwards syndrome) and 21 (Down syndrome) and some deletion syndromes (Del 4q 21, 32, Del 5p and Del 22q11) [11,12].

Diagnosis is made from a combination of clinical and laboratory findings. Clinical features depend on the size of the defects, presence of other cardiac defects and relationship between systemic and pulmonary vascular resistance. Patients with small defects may be asymptomatic with an incidental finding of a systolic murmur on auscultation of the chest during a routine examination. On the contrary, individuals with large defects may present in infancy with a history of recurrent chest infection or failure to thrive. Electrocardiography may be normal in small defects with larger defects presenting with features that range from the evidence of left ventricular enlargement to left atrial enlargement, right axis deviation, right ventricular hypertrophy and right atrial enlargement in cases of elevated pulmonary artery pressure [12]. Chest radiograph has no apparent radiologic abnormality in small defects. Larger defects presented with chamber enlargement and increased pulmonary vascularity. Echocardiography is diagnostic demonstrating the size and location of the defects and complications such as elevated pulmonary artery pressure, obstruction of the right ventricular outflow tract and insufficiency of the aortic valve that may occur with it [12].

Management of a child with VSD is both medical and surgical, and this depends on the symptoms. With a small defect, watchful waiting is advocated to observe for spontaneous closure. Patients with congestive cardiac failure are treated with diuretics, digoxin, and afterload treatment. Anticipation and prevention of infective endocarditis, a lifelong risk in untreated patients, is done. Surgical correction of the defect may be required in some patients. This is however not available in resource-poor countries, and only a few patients can afford surgical correction abroad [13]. The majority of patients in our environment thus receive only medical treatment. The prognosis of isolated VSD is good with a high rate of spontaneous closure in the first two years of life. Although the incidence of

VSD has been reported in other reports of CHD has been reported in the region. None has considered VSD as a separate entity. Other previous studies on CHD in the region had also been for a short period of time (at best two years) with fewer sample sizes hence the need for this study which aims to document the prevalence and clinical profile of children with VSD in a tertiary hospital in Sub-Saharan Africa using data collected over a longer period of time (Nine years) and involving more subject which is likely to be more representative of the characteristics of children with VSD in the region. This study also aims to provide data for future reference on VSD. It will also make data available for health planning by policy makers and advocacy in the care of these children.

## 2. METHODS

This study was conducted at the Department of Paediatrics, Lagos state university teaching hospital Lagos. The hospital is located in South Western Nigeria. The Department of Paediatrics is an 84 bedded unit with a Paediatric cardiologist in charge of the cardiology unit. The cardiology unit has a facility for Electrocardiography (ECG), Echocardiography and cardiac catheterization. Children are referred from within the state and in the sub-region for cardiac evaluation.

The children were less than 13 years of age because the hospital policy requires that older patients are seen by the physicians. Between January 2007 and December 2015, all the children less than 13 years of age with echocardiography diagnosis of VSD were consecutively recruited. All the patients had a complete history and physical exam done by the cardiology unit. Chest radiograph and ECG were done as required. Other ancillary investigation done were also done on an individual and case required basis. Echocardiography was performed using a 2-D echocardiography machine with facility for colour Doppler and M-mode. It is a GE Vivid Q echocardiography machine with reference number 14502 WP SN 2084. One machine was used throughout the study period, and the Paediatric cardiologists performed the echocardiography on all the study subjects. A diagnosis of VSD was confirmed by a transthoracic echocardiography demonstrating the defects.

Echocardiography was done as part of routine care for the children thereby excluding the need for clearance by hospital ethical committee [7].

Details concerning the patient's biodata, clinical presentation, diagnosis, treatment, follow-up and other relevant information were recorded prospectively. All the patients were followed up at the Paediatric cardiology clinic. The patients received medical treatment as required. Those who required surgical closure of the defects were referred outside Nigeria for treatment. Those patients who had surgical correction were referred to the unit after the correction, and they were followed up in the unit.

The data were analysed using Statistical Package for Social Sciences (SPSS) version 20. The children's age, sex, indication for echocardiography and echocardiographic findings were represented in tables and charts. VSD was categorized into isolated VSD and VSD associated other congenital heart diseases. The prevalence of VSD was calculated from all children who presented to the hospital and also amongst those with congenital heart lesions. Descriptive statistic was presented as percentages or means and standard deviation. Means of normally distributed variables were compared using the Student T test and proportions using Chi-square test. Skewed distribution was analysed using appropriate non-parametric tests. The level of significance set at $p< 0.05$.

## 3. RESULTS

### 3.1 Demographic Characteristics of the Patients

A total of 352 patients had an echocardiographic diagnosis of VSD. Of the 352 patients with VSD, 157 had isolated VSD while 195 had VSD associated with other heart defects (excluding Tetralogy of Fallot). The subjects were 183 males and 165 females with a male to female ratio of 1.1:1. The children were aged four days to 13 years, with a mean of 25.18±37.41 months and the median age of eight (8) months. Figs. 1 and 2 are representative images of the chest radiograph and an echocardiographic image of a patient with ventricular septal defect.

The patients with isolated VSD were 86 males and 70 females with a male to female ratio of 1.2:1. The youngest child was four (4) days old while the oldest was 13 years old. The distribution of the age of the subjects was skewed to the left with a mean of 29.08±36.13 months. The median and modal ages were 12 and three months respectively. The ages of the patients were divided into various subgroups as

depicted in Table 1. Most of the patients presented within the first six (6) month and the first five years of age; 30.6% and 31.2% respectively.

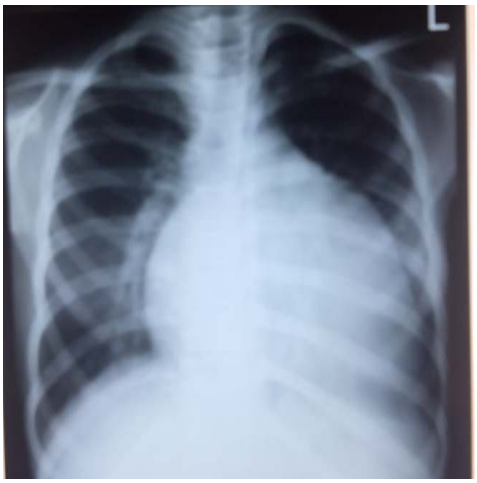

**Fig. 1. Chest radiograph of a patient with ventricular septal defect showing cardiomegaly, left atrial dilatation and left ventricular enlargement with dilated main pulmonary artery**

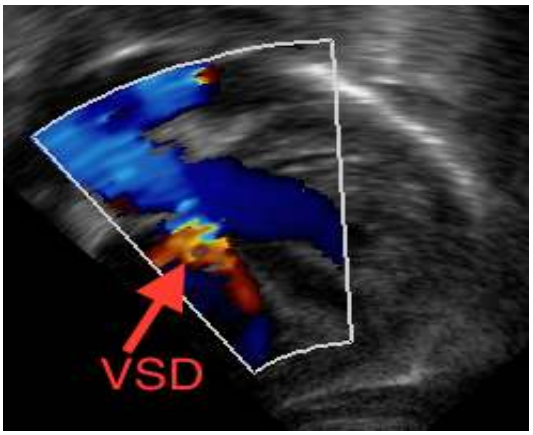


**Fig. 2. Apical five chamber view of an echocardiogram showing a ventricular septal defect**

The patients with VSD associated with other congenital heart disease were 97 males and 95 females with a male to female ratio of 1:1. They were aged, five days to 13 years, (21.18±36.87) with a median and modal age of five (5) and one (1) month respectively. A third of the patients presented within the first six (6) month of age.

Regarding the demographic characteristic of the two subgroups, there was no significant difference in the gender of both groups ($p > 0.05$). However, there was a significant difference in the distribution of the age groups between both groups of patients. The patients with VSD associated with other congenital heart diseases had more patients diagnosed in the first six months of age compared to those with isolated VSDs. On the contrary, there were more patients diagnosed within the first five years of age amongst the patients with isolated VSD compared to those with VSD associated with other congenital heart anomalies. The demographic characteristics of the patients are shown in Table 1.

### 3.2 Prevalence of VSD

Between January 2007 and December 2015 a total of 328,642 children were seen at the Paediatric Department during the study period, and 1,133 children had congenital heart disease. Of the 1,133 patients with CHD, 352 patients had VSD out of which isolated VSD was documented in 157 children while 195 had VSD associated with other congenital heart diseases. The prevalence of all VSDs among children who presented at the study center during the study period was 10.7 per 10,000 children, and isolated VSD was 4.7 per 10,000 children. The prevalence of VSD amongst other congenital heart diseases was 31.1 and 13.9% for all VSDs and isolated VSDs respectively. Fig. 3 depicts the schematic presentation of the prevalence of VSD.

### 3.3 Clinical Presentation

The most common reason for cardiac evaluation of the patients was a presumptive diagnosis of an acyanotic congenital heart disease from a history and physical examination; documented in half of the patients (50.3%). This was a similar finding in both subgroups of VSDs. Some of the patients had chromosomal anomalies such as Down syndrome and Edwards syndrome. A few patients had an incidental finding of a murmur (5.9%). Various characteristics of multiple congenital disorders, tracheoesophageal fistula, cleft lip, and palate, etc. were also documented in the patients. The indication for cardiac evaluation is shown in Fig. 4.

### 3.4 Distribution and Characteristics of the VSD Types

Of the 195 patients with VSD associated with other cardiac defects, Atrial Septal Defect (ASD)

closely followed by Patent Ductus Arteriosus (PDA) were the most common congenital heart defects (Table 2). Double Outlet Right Ventricle (DORV) was the most common cyanotic congenital heart disease occurring in 19.5% of all the patients either singly with VSD or in combination with other CHDs. The most predominant type of VSD was perimembranous VSD occurring in 31% of all VSDs. This was closely followed by Sub-aortic VSD, which was documented in 26.1% of all VSDs. The distribution of the types of VSDs was similar amongst the two subgroups for perimembranous, sub-aortic and inlet VSDs. Muscular VSD were more common in the isolated VSD compared to the VSD with other associated CHD. (p = 0.024). The combinations of the various types of VSD was only documented amongst the group of VSDs associated with other congenital heart diseases. The various characteristics of the ventricular connections are shown in Table 3.

**Table 1. Demographic characteristics of the patients**

| Variable | Total N=352 (%) | Isolate VSD N=157 (%) | VSD with other CHD. N=195(%) | P value |
|---|---|---|---|---|
| **Gender** | | | | |
| Male | 183 (52) | 86 (54.8) | 97 (49.7) | 0.392 |
| Female | 165 (46.9) | 70 (44.6) | 95 (48.7) | 0.444 |
| **Age group** | | | | |
| ≤ 6 months | 147 (41.8) | 48 (30.6) | 99 (33.6) | < 0.001* |
| 6 months to ≤1 yr | 55 (15.6) | 29 (18.5) | 26 (13.3) | 0.187 |
| >1 yr to ≤5 yrs | 82 (23.3) | 49 (31.2) | 33 (16.9) | 0.002* |
| >5 yrs to ≤10 yrs | 30 (8.5) | 18 (11.5) | 12 (6.2) | 0.077 |
| >10 yrs | 12 (3.4) | 5 (3.2) | 7 (3.6) | 0.834 |
| **Mean age (Months)** | 25.18±37.41 | 29.08±36.13 | 21.18±36.87 | |
| **Median age (Months)** | 8 | 12 | 5 | 0.707 |

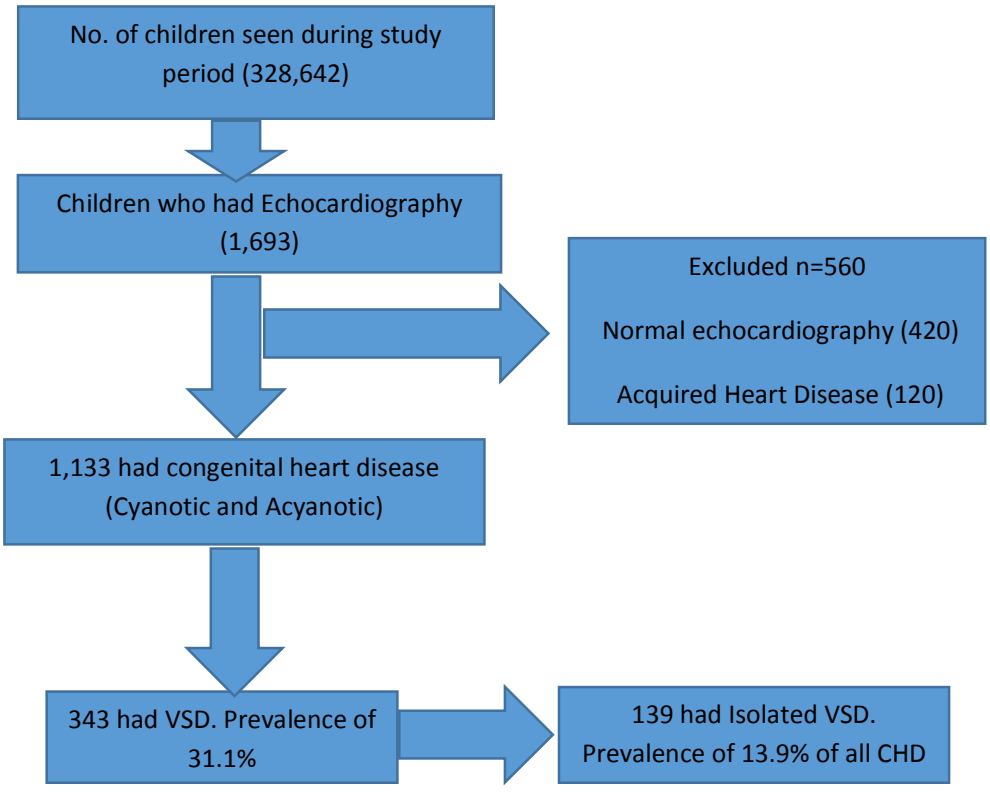


**Fig. 3. Study flow diagram and prevalence of VSD**

## 4. DISCUSSION

There are very few published reports of on children with VSDs in Nigeria and the Sub-Saharan African. Most of the available reports on VSD were from studies of congenital heart diseases in children and adults. To the best of the authors' knowledge, there are only two published reports on VSD in children in Nigeria. This study has the largest number of cases of VSD in children in Nigeria. The prevalence of VSD in children and amongst the congenital heart diseases and the characteristics and types of VSDs are documented in this report.

**Table 2. Prevalence of other congenital heart defects in the VSD associated with other cardiac defects**

| Type of CHD | n = 195 (%) |
|---|---|
| VSD + ASD | 41 (21) |
| VSD + ASD + PDA | 12 (6.2) |
| VSD + PDA | 40 (20.5) |
| VSD + PS | 19 (9.7) |
| VSD + ASD + PS | 11 (5.6) |
| VSD + AS + PDA | 3 (1.5) |
| ASD + AS | 3 (1.5) |
| VSD + DORV | 22 (11.5) |
| VSD + ASD + DORV | 8 (4.1) |
| VSD + TA | 6 (3.1) |
| VSD + TGA | 17 (8.7) |
| VSD + TGA + DORV | 8 (4.1) |
| VSD + HPLV | 2 (1.0) |
| VSD + TAPVC | 1 (0.5) |
| VSD + Cotriatrium | 1 (0.5) |
| VSD + Truncus arteriosus | 1 (0.5) |

*ASD = Atrial Septal defect, AS = Aortic Stenosis, CHD = Congenital Heart Disease, DORV = Double Outlet Right Ventricle, HPLV = Hypoplastic Left Ventricle, PDA = Patent Ductus Arteriosus, TA = Tricuspid Atresia, TGA = Transposition of the Great Vessels*

The population prevalence of VSD herein documented was within the rate of previous reports documented in western countries [3]. The major difference lies in the denominator of the rates. While the present study has a population of children less than or equal to 13 years, the earlier reports involved live birth [3]. The population prevalence was also similar to reports documented from an earlier study that was done on an adult population in the USA [14]. It, therefore, means that the prevalence of VSD is similar across a wide geographical location, and that difference in race and geographical regions does not affect it. There were no population study reports of VSD in Nigeria and the sub-region at the time of this write-up.

The prevalence of all VSD amongst the congenital heart disease was 31.1%, and this was within previously documented rates of 27.6-55% in Nigeria [4-8]. The prevalence was also similar with other reports outside Nigeria [15-18]. The prevalence of isolated VSD in the present study was lower than previous reports on isolated VSD in other countries and within Nigeria, which had rates of 20-40% [19-22]. Possible explanations for the low rate of isolated VSDs may be because some patients with small VSDs may be asymptomatic and the defect may have closed spontaneously before diagnosis was made. Other reasons lie within the context of poor health seeking behavior of the population of study, with patients only presenting when symptoms are overwhelming. The prevalence, therefore, may thus be an underestimate of the true picture.

Concerning the demographic characteristics of the study population, the median age at diagnosis of the patient was lower for the patients with VSD associated with other CHD compared to those with isolated VSD. This was also obvious with the sub-group distribution of age at diagnosis where it was noted that the patients with VSD associated with other CHD had more patients diagnosed within the first six months of age compared to the patients with isolated VSDs. Also, there were more patients diagnosed within the first five years of life in the isolated VSD category compared to the group with other CHD associated with VSDs. Although there are few studies that have distinguished isolated VSD from VSD associated with other CHD, other researchers also documented that the diagnosis of VSD was documented in children within the first five years of life with a mean of 24 months [22]. Other authors have reported ages that ranged from 1month to 5 years which are similar to the findings in the present study [20,22-24]. Other reports differ in the ages at diagnosis based on the characteristics of the study population. The finding of an earlier age at diagnosis of VSD associated with another CHD compared to isolated VSD is not unconnected with the type of associated CHD. The patients with one or more combinations of CHD co-existing with VSD may present earlier with clinical symptoms necessitating investigations and diagnosis. Thus, they were diagnosed at an earlier age.

**Table 3. Characteristic of VSDs**

| Characteristics of VSD | Total n = 352 | Isolated VSD n = 157 (%) | VSD with other CHD n = 195 (%) | P value |
|---|---|---|---|---|
| Perimembranous | 109 (31) | 53 (33.7) | 56 (28.7) | 0.308 |
| Sub-aortic | 92 (26.1) | 44 (28) | 48 (24.6) | 0.472 |
| Muscular | 24 (6.8) | 16 (10.2) | 8 (4.1) | 0.024* |
| Inlet | 38 (10.8) | 16 (10.2) | 22 (11.3) | 0.741 |
| Sub-aortic + Inlet | 2 (0.6) | 0 | 2 (1.0) | |
| Inlet + Perimembranous | 6 (1.7) | 0 | 6 (3.1) | |
| Sub-pulmonic | 2 (0.6) | 0 | 2 (1.0) | |
| Unknown | 79 (22.4) | 28 (17.8) | 51 (26.1) | |

*a p-value less than 0.05 was significant*

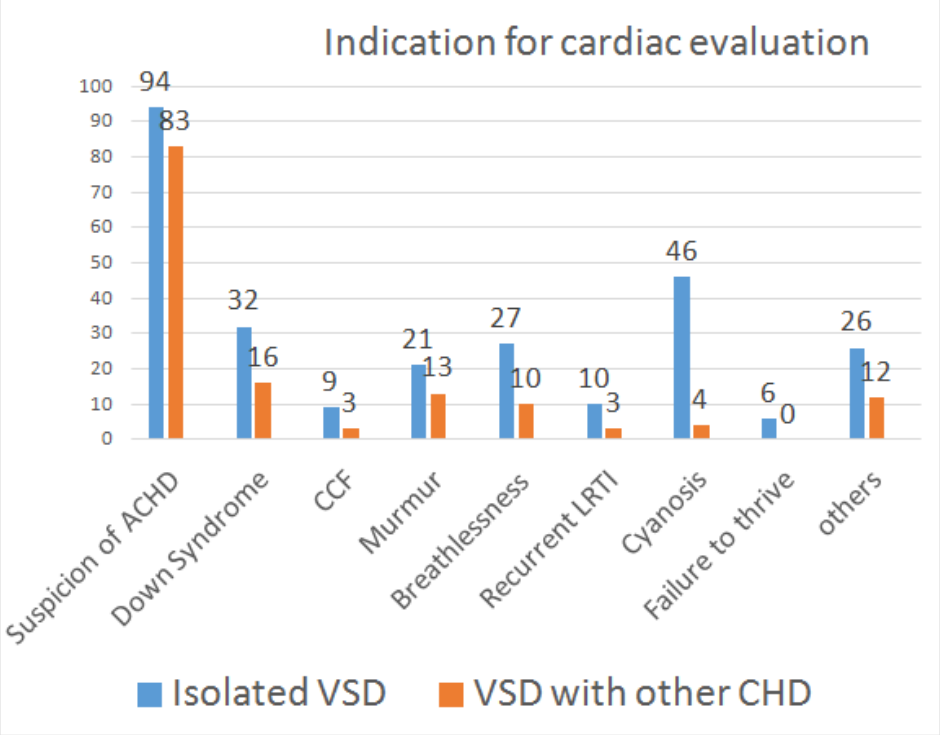


**Fig. 4. Indication for cardiac evaluation in the subjects**

*ACDH= Acyanotic Congenital Heart Disease, CHD= Congenital Heart Disease, CCF= Congestive Cardiac Failure, LRTI = Lower Respiratory Tract Infection. Others = Edward Syndrome, Multiple congenital heart disease, Stroke, Chest pain, Cleft lip and palate, tachycardia, recurrent fever, twin with CHD and Tracheoesophageal fistula. Most patients had more than one reason for cardiac evaluation*

It is known that VSD has a slight female predominance [11]. In the present study, there was no gender difference in the distribution of all the VSDs. While some studies have reported slight male predominance, [5,23,25] others have documented slight female predominance [8,26] and others no gender difference as in the present study [22].

For congenital heart defects associated with VSD, the present study documented ASD closely followed by PDA as the commonest associated CHD. The finding in this regard is similar to previous reports by Ejim et al. [25] in South Eastern Nigeria almost two decades ago. Sadoh et al. [26] in South Southern Nigeria reported TOF followed by ASD as the most common CHD associated with VSD. Compared to the report by Sadoh et al. [26] the present study excluded patients with TOF. In the research by Manuel et al. [22] in Angola PDA was the most common CHD followed by Pulmonary Stenosis and ASD.

It is clear from this study and the previous reports that acyanotic CHD and to be specific ASD, PDA and PS are the most common CHD associated with VSD.

Worldwide, perimembranous defects are the most common defects of the ventricular septal accounting for up to 80% of all defects in the ventricular septum [11]. Not surprising, perimembranous VSD was the most common type of VSD for both the isolated VSD and VSD associated with other CHD. The finding in this regard is also similar to previous reports [23,26] .Subaortic VSD was the second most common type closely following the perimembranous subtype while muscular VSD was the least common. This is in contrast with known reports, where muscular VSD is second to perimembranous VSD [11]. Other researchers have also reported muscular VSD as the second most common subtype of VSD in contrast with the present study [26]. The patients with VSD associated with other CHD had other combinations of VSD Subtype. This finding may be related to the type of associated CHD.

The aetiology of VSD is unknown. But multifactorial aetiology based on some genetic or chromosomal abnormalities interacting with environmental factors have been explained [11,12]. In the present study children with clinical features of Down syndrome were the most common chromosomal abnormalities. Similarly, in a review of congenital diseases associated with identified syndromes and other extracardiac malformations in a tertiary hospital in Nigeria, Ekure et al. [27] reported Down syndrome as the most common syndromes in patients with VSD. This is not surprising given the fact that up to 60% of children with Down syndrome have CHD [28], AVCD and VSD are the two most common CHD in those patients [28-30]. Two cases of Edward syndrome were also noted in the present study. It is known that almost 90% of patients with Edwards syndrome have CHD and VSD is one of the most common [31]. Thus, the finding of Edward syndrome amongst the patients in the present study is not surprising. The earlier research by Ekure et al. [27] also reported a case of Edwards syndrome in children with VSD [26]. There was a case of a twin with a CHD and the second twin had a VSD. This may have been an occurrence of chance, but it is known that a family member with a CHD increases the risk of a CHD in the patient compared to the general population [11]. Given that syndromes such as Downs and Edwards and a case of siblings with CHD were documented in the present study, it is imperative that all patients with dysmorphologies and chromosomal abnormalities be screened for CHD. Also, when a sibling has a VSD, the parents should be counselled on the possibilities of a recurrence in other siblings and screening done on other children in the household.

## 5. CONCLUSION

In conclusion, this study has documented both population prevalence and prevalence of VSD among other CHD. Rates were generated for both isolated VSD and VSD associated with other CHD. The clinical characteristics of the VSD were also documented. This report has shown that racial and geographic differences do not play a role in the prevalence and clinical profile of VSD because the findings in the present study in various aspects are similar to previous reports outside the region with a few exceptions.

## CONSENT

It is not applicable.

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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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