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NIGERIA**

ASSESSMENT OF LEFT VENTRICULAR SYSTOLIC DYSFUNCTION AMONG HUMAN IMMUNODEFICIENCY VIRUS INFECTED CHILDREN IN ILORIN NORTH-CENTRAL NIGERIA

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ABSTRACT

Introduction: Human immunodeficiency virus (HIV) is a multi-systemic infection affecting the cardiovascular system with the left ventricle particularly at a higher risk. Most children with this infectious disease acquired it early in their lives through vertical transmission, thus they live to contend with its attendant complications from chronicity. Echocardiography is one of the gold standards for the assessment of cardiac function of these children. This study determined the prevalence of left ventricular systolic dysfunction among HIV infected children.

Methods: A comparative cross-sectional study among 100 HIV infected subjects and an equal number of HIV negative controls aged 2–14 years were recruited consecutively through the Paediatric HIV and out-patient clinics respectively. Recruitments and echocardiography for both groups lasted 4 months. Data was analysed with SPSS[®] v 20. Results were presented in tables as frequencies and percentages. Mean and standard deviation of normally distributed data were determined. Categorical variables were compared using chi square test. Significant p is < 0.05 .

Results: The mean age of participants was 9.42 ± 2.99 years. There were more males with M: F of 1.4:1. Two-thirds were of the

lower social class and at the asymptomatic phase while almost all were on HAART. The prevalence of left ventricular systolic dysfunction among subjects was 36% compared with 18% among controls ($p = 0.004$).

Conclusions: HIV-infected children are twice predisposed to developing left ventricular systolic dysfunction compared with the HIV negative children. Most of the HIV infected children in this study were males, at the asymptomatic phase, on HAART and belonged to the lower socio-economic status.

Key words: Children, Dysfunction, HIV, Systolic, Ventricular.

INTRODUCTION

The human immunodeficiency virus (HIV) has become one of the world's most serious health and developmental challenges with its biggest burden in sub-Saharan Africa.^{1,2} Globally, there were 37.7 million people living with HIV/AIDS in 2020 with children accounting for 1.7 million of these.³ Despite the decline in new HIV infections, there were 1.5 million estimated new infections in 2020: 160,000 and 1.3 million of the new infections were among children and adults respectively.³ Although, the

United Nations AIDS 90-90-90 target was missed, however, by the end of 2020 84% of people living with HIV knew their status, 73-87% of those who knew their status were accessing antiretroviral therapy and 66-90% of people on treatment were virally suppressed.^{3,4}

The prevalence of HIV in Nigeria from the recently concluded National HIV/AIDS Indicator and Impact Survey (NAIIS) is 0.2% among children.⁵ HIV infection is a multi-systemic disease and progresses more rapidly in children compared with adults.^{6,7,8} Existing literature describes the spectrum of cardiac diseases in adults with HIV, but the extent of cardiovascular involvement has not been well-reported in children.⁶

Evaluation of left ventricular systolic dysfunction is done using the diagnostic tool, echocardiography.⁹ Echocardiography is the ultrasound of the heart and the gold standard in the assessment of left ventricular systolic functions.¹⁰ It is benign, non-invasive and generally devoid of risk. A study in Enugu South-Eastern Nigeria reported left ventricular systolic dysfunctions in 81.2% of children with HIV.¹¹ In addition, a study from Lagos South-Western Nigeria found left ventricular systolic dysfunction in 15% of children with HIV.¹² These studies were done in different geo-political regions from ours in the North-Central Nigeria. The latter was done using a smaller sample size of thirty-nine, while the former done with a larger sample size was done a decade ago.

This study determined the prevalence of left ventricular systolic dysfunction using echocardiography among HIV infected children and HIV negative controls at the University of Ilorin Teaching Hospital, Ilorin, Kwara State, Nigeria. The state belongs to the North-Central region, the zone that is second only to the South-South geo-political zone in HIV prevalence.⁵ Despite this burden and to our knowledge, no previous study has been done to seek to determine the impact of HIV/AIDS on the left ventricular systolic dysfunction among children in the state.

METHODS

Study Design

This was a comparative cross-sectional study of children aged 2 – 14 years living with HIV and those without the infection. They were screened for the presence of left ventricular systolic dysfunction. The study was conducted between August to November 2017.

Study Site/Population

The study was conducted at the Paediatric Antiretroviral Therapy (ART) clinic of University of Ilorin Teaching Hospital (UIH), located in Ilorin East Local Government Area of Kwara State in Nigeria. The Hospital is a tertiary health facility that serves as a referral centre for patients from Kwara and neighbouring States of Osun, Niger, Kogi and Ekiti.¹³ There were 180 children on HIV treatment and care, with 130 of them on HAART.¹⁴ There is a designated HIV clinic every Monday with facilities for doing free (as at the time of this study) full blood count, CD4 count and antiretroviral care (enrolment, counselling, monitoring on follow up and free highly active antiretroviral therapy). The site operates a Paediatric Cardiology clinic at another designated site on Tuesdays with access to three echocardiography machines (paid for by the researchers in this instance). The echocardiographic sessions were done from Mondays to Thursdays but fully on Thursdays (the day set aside for Paediatric Echocardiography only).

Ilorin is the capital of Kwara State in the North-Central geo-political zone of Nigeria. Kwara State has a population of 2.37 million from 2006 census.¹⁴ The Nigeria HIV/AIDS indicator and impact survey (NAIIS) reported the National prevalence of HIV as 0.2% and 1.5% among children and adults respectively (2019) with the South – south and North – west zones having the highest (3.1%) and the lowest (0.6%) prevalence respectively. The North – central zone is the second highest with a prevalence of 2.1%.⁵

Sample size estimation

The minimum sample size was determined using the formula for comparative study;¹⁵

$$n = \frac{C_{power} \times P1[1 - P] + P2[1 - P2]}{[P1 - P2]^2}$$

Where n = minimum sample size, Cpower is 13.0, made up of Z α (probability of type I error) at 5% and Z β (probability of type II error) at 95%; P1 = Prevalence of left ventricular systolic dysfunction among HIV infected children is 27.0% and P2 = Prevalence of systolic dysfunction among controls is 2.2% as reported by Arodiwe *et al*¹¹

$$n = \frac{13.0 \times 0.270 [1 - 0.270] + 0.022[1 - 0.022]}{[0.270 - 0.022]^2}$$
$$n = \frac{13.0 \times 0.1971 + 0.021516}{0.061504} = \frac{2.562236}{0.061504} = 41.66 \approx 42$$

Although the calculated sample size is 46 but that is just the minimum sample size calculated, increasing sample size is known to further enrich study precision and its deductions (The higher the sample size, the better the study). A total of 100 children living with HIV were recruited as subjects and an equal number of HIV uninfected children recruited as control so as to increase the power of the study. All the children living with HIV were given the opportunity to be part of the study by explaining the purpose of the study as well as its benefits.

Sampling technique

A convenience sampling technique was used and participants recruited consecutively until the desired number was attained.

Participants' recruitment

Recruitment of subjects for the study was done at the Antiretroviral Therapy (ART) clinic, UITH. HIV-infected children attending the ART clinic that fulfilled the inclusion and exclusion criteria were recruited consecutively into the study after obtaining a valid written informed consent from the parents/care-givers and assent where applicable. The controls were age- and sex-matched HIV-uninfected children who fulfilled the criteria below, among children attending the paediatric out-patient clinic.

HIV diagnosis was based on a serial testing using the Rapid Kit (Determine[®], Stat Pak[®] or Unigold[®]) sequentially. A negative test to Determine[®] kit (the preferred because of its sensitivity) implies HIV negativity. A positive Determine[®] test is confirmed with either the Stat Pak[®] or Unigold[®]. A discordance of results was confirmed with a third kit (Unigold[®]) which served as a tie-breaker.¹⁷

Inclusion Criteria for Subjects/Controls

1. Confirmed HIV infected/HIV negative
2. Age 2-14 years
3. Parental consent for the study.
4. Assent (for children aged seven years and above)

Exclusion Criteria for Subjects/Controls

1. Children with pre-existing congenital and/or acquired heart diseases such as septal defect and rheumatic heart diseases respectively.
2. All children with chronic diseases known to affect cardiac function including sickle cell disease (SCD) and nephrotic syndrome based on available investigations in the medical records.
3. Children with malignancies and protein energy malnutrition (not HIV related).
4. Children with connective tissue diseases such as systemic lupus erythematosus (SLE). Exclusion was based on criteria for clinical diagnosis.¹⁸
5. Children receiving medications (non-antiretroviral) with cardiac related complications such as doxorubicin.
6. Patients with severe anaemia (packed cell volume PCV \leq 15% or any PCV with cardiac decompensation). (Two patients were found ineligible as they had features of decompensation, they were admitted and managed)

Ethical approval

Ethical clearance was obtained from the University of Ilorin Teaching Hospital's Research Ethics Committee with clearance number ERC.PAN/2016/04/1525. A written

informed consent was obtained from the individual parent/care-giver; assents were also obtained from subjects seven years and above, after a clear explanation to them of the objectives and mode of execution of the study.

Recruitment Procedure

The parents/care-givers of eligible subjects were approached and details of the study explained to them. Informed consent was obtained from the parent/care-giver and an assent obtained from children aged seven years and above after explaining the study to them. A semi-structured questionnaire was administered by the researcher at the clinic and responses filled in immediately. The questionnaire was pre-tested through a pilot study to check for understanding, appropriateness of the questions and for clarity to avoid ambiguity.

Clinical Evaluation

Social class of the subjects was determined by the Oyediji classification.¹⁹ A detailed history that includes biodata, duration since HIV diagnosis, current medications and symptoms were taken. Cardiovascular examination in a well-lit room was carried out on each patient to identify features suggestive of cardiac diseases such as pedal oedema, ascites, raised jugular venous pressure (JVP), dyspnoea, tachypnoea, tachycardia, cardiomegaly and tender hepatomegaly etc. HIV disease in the child was classified according to the World Health Organization (WHO) clinical staging criteria (Table 1).²⁰

Echocardiography

Echocardiography was done using the SSI-8000 Sonoscape® China sonogram machine. The procedure was explained and safety of the procedure was assured. They were made to stay calm during the procedure, achieved by allowing the care-giver (especially the mother) to be by their side.

A detailed echocardiography was done and the intracardiac anatomy determined according to the standard guidelines.²¹ The left ventricular systolic function (measured using the fractional shortening FS and ejection fraction EF) was also taken.²¹ The M-mode measurements of left ventricular systolic function were derived from the parasternal short axis view at the mid-papillary level and the following measurements were obtained according to the American Society of Echocardiography guidelines: Left ventricular end-diastolic diameter (LVEDd), LV end-systolic diameter (LVESd), ventricular septal and posterior wall thickness in diastole.^{21,22}

Left ventricular ejection fraction was calculated using the following formulae:²²

$$EF (\%) = \frac{LVEDd^3 - LVESd^3}{LVEDd^3} \times 100 \quad (\text{machine derived})$$

These parameters were automatically generated by the echocardiography machine used for the study. Two dimensional (2D) echocardiograms were done using the above echocardiogram machine with a 3.5 – 7.5 MHz probe.

Table 1: WHO Classification of HIV-Associated Immunodeficiency in Children

HIV-associated immunodeficiency class	Age-related CD4 values		
	12 – 35 months %	36 – 59 months %	≥ 60 months cells /mm ³
Asymptomatic	>30	>25	>500
Mild	25 – 30	20 – 25	350 – 499
Moderate	20 – 24	15 – 19	200 – 349
Severe	<20	<15	<200 or <15%

Left Ventricular Systolic Dysfunction

The diagnosis of left ventricular systolic dysfunction was made with either of the following:

- The Fractional Shortening (FS) is the percentage change in the left ventricular cavity diameter in systole. It is calculated as $FS (\%) = \frac{LVEDd - LVESd}{LVEDd} \times 100$. The normal FS ranges between 28 – 41%.¹¹ Depressed Fractional shortening is FS of < 28%.²³
- Ejection Fraction (EF) is the percentage of the left ventricular volume that is ejected during systole. It is calculated as $EF (\%) = \frac{LVEDd^3 - LVESd^3}{LVEDd^3} \times 100$. The normal EF range between 54 – 75%.²³ Depressed Ejection fraction is EF of < 54%.²³

Myocardial Performance Index (MPI), is also known as the Tei index.²³ The technique is a combine marker of systolic and diastolic dysfunction. It measures both the left ventricular inflow and outflow velocities by placing the sampling volume on the left ventricular outflow close to the anterior leaflet of mitral valve, making it a simultaneous or near simultaneous determination of the mitral inflow and the left ventricular outflow.²³ $MPI = (IVCT + IVRT) / ET$ where IVCT is the isovolumic contraction time (which is the interval between the end of atrial contraction part of mitral inflow and the onset of left ventricular outflow), IVRT is the isovolumic relaxation time (the interval between the end of left ventricular outflow and the onset of mitral inflow) and ET is the systolic ejection time (the duration of left ventricular outflow). The Myocardial performance index $MPI > 0.45$ seconds is a direct correlation of a poor ejection fraction.²³

The lead researcher was a pre-part II resident doctor in Paediatrics who had worked under training in Paediatric Cardiology unit for over 24 months (at the time of conducting

this study). He trained under two Paediatric Cardiologists who supervised him (as part of his part II dissertation) and cross – checked at random after every 5 – 10 echocardiography sessions to ensure quality control and validation of results.

Data Analysis

Data analysis was done using Statistical Package for Social Sciences (SPSS)[®] version 20. Tables were used to report descriptive statistics. Mean and standard deviation (SD) of normally distributed data was done. Categorical variables were compared using the chi square test (Yate's correction done as appropriate) while continuous variables were analysed using the student t-test. The level of significance was set at $p < 0.05$.

RESULTS

The mean age of subjects was 9.42 ± 2.99 years.

Distribution of subjects based on HAART status HIV/AIDS classification

A total of 73% of the subjects were at the asymptomatic phase of the disease while 14% had severe disease based on their CD4 counts. Most (84%) were on first line HAART while 6% were HAART-naïve as at the time of recruitment (Table 2).

Table 2: Distribution of subjects based on HAART status HIV/AIDS classification

Variable	Frequency n (%)
Immuno-deficiency classification	
Severe	14 (14.0)
Moderate	7 (7.0)
Mild	6 (6.0)
Asymptomatic	73 (73.0)
HAART Status	
Naïve	6 (6.0)
First line	84 (84.0)
Second line	10 (10.0)

Prevalence of Left Ventricular Dysfunction among HIV Infected subjects and controls

There were significant differences between the left ventricular systolic dysfunction among children living with HIV and those living without it ($p = 0.001$). Similarly, there were significant differences in the left ventricular systolic dysfunction between those living with HIV and those without ($p = 0.004$). In addition, Myocardial Performance Index (MPI) also showed a statistically significant difference in left ventricular dysfunction between those living with the disease and those without ($p = 0.001$, table 3).

Mean Left Ventricular Parameters in HIV Infected Subjects and HIV Negative Controls

The mean Fractional Shortening (FS) and Ejection Fraction (EF) of the HIV positive children were lower than that of the HIV

negative children, but there was no statistically significant difference ($p = 0.176$ and $p = 0.207$ respectively). A statistically significant difference was present with a lower mean ejection time (ET) in the HIV infected cases compared with the controls. A significantly higher myocardial performance index (MPI) was found among subjects than the controls ($p = 0.001$, table 4).

Relationship between Occurrence of Left Ventricular Systolic Dysfunction and Socio-demographics characteristics of subjects

There was a significant association between degree of immune suppression and presence of left ventricular systolic dysfunction ($p = 0.001$), but no significant relationship between age group, gender, social status and left ventricular systolic dysfunction ($p = 0.778$, table 5).

Table 3: Prevalence of Left Ventricular Systolic Dysfunction among HIV Infected subjects and controls

HIV status					
	Positive	Negative	Total	χ^2	p-value
Variable	n (%)	n (%)	N (%)		
LEFT VENTRICULAR SYSTOLIC DYSFUNCTION					
Fractional shortening (FS)					
Dysfunction	36 (36.0)	18 (18.0)	54 (27.0)	8.219	0.004
Normal	64 (64.0)	82 (82.0)	146 (73.0)		
Ejection fraction (EF)					
Dysfunction	34 (34.0)	20 (20.0)	54 (27.0)	4.972	0.026
Normal	66 (66.0)	80 (80.0)	146 (73.0)		
LEFT VENTRICULAR DYSFUNCTION USING MPI					
Dysfunction	46 (46.0)	2 (2.0)	48 (24.0)	11.054	0.001
Normal	54 (54.0)	98 (98.0)	152 (76.0)		

MPI; Myocardial Performance Index, χ^2 : Chi square test; *: p value <0.05

Table 4: Mean Left Ventricular Parameters in HIV Infected and HIV Negative Controls

HIV STATUS				
	Positive	Negative		
Variables	Mean ± SD	Mean ± SD	t	p value
Left ventricular systolic function				
Ejection Fraction (EF)	56.43 ± 9.92	58.00 ± 7.44	-1.266	0.207
Fractional Shortening (FS)	29.87 ± 6.67	31.01 ± 5.11	-1.358	0.176
Isovolumic Contraction Time (IVCT)	0.43 ± 0.08	0.43 ± 0.09	0.363	0.717
Isovolumic Relaxation Time (IVRT)	0.64 ± 0.09	0.64 ± 0.08	0.032	0.975
Ejection Time (ET)	2.59 ± 0.53	2.79 ± 0.48	-2.889	0.004*
Left ventricular systolic and diastolic function				
Myocardial Performance Index (MPI)	0.42 ± 0.06	0.39 ± 0.05	4.396	<0.001*

t: Independent samples t test; MPI: Myocardial performance index *: p value <0.05

Table 5: Relationship between occurrence of Left Ventricular Systolic Dysfunction and Socio-demographics characteristics of subjects

Left ventricular dysfunction					
	Yes	No	Total	χ^2	<i>p</i> value
Variable	n=46 (%)	n=54 (%)	N=100		
Age (years)					
3 – 5	6 (6.0)	7 (7.0)	13 (13.0)	1.097	0.778
6 – 8	13 (13.0)	12 (12.0)	25 (25.0)		
9 – 11	12 (12.0)	19 (19.0)	31 (31.0)		
12 – 14	15 (15.0)	16 (16.0)	31 (31.0)		
Sex					
Male	27 (27.0)	31 (31.0)	58 (58.0)	0.017	0.896
Female	19 (19.0)	23 (23.0)	42 (42.0)		
Social class					
Upper	2 (2.0)	2 (2.0)	04 (4.0)	1.079 ^F	0.670
Middle	12 (12.0)	19 (19.0)	31 (31.0)		
Lower	32 (32.0)	33 (33.0)	65 (65.0)		
Immuno-deficiency class					
Severe	12 (12.0)	2 (2.0)	14 (14.0)	14.025 ^F	0.001*
Moderate	5 (5.0)	2 (2.0)	7 (7.0)		
Mild	3 (3.0)	3 (3.0)	6 (6.0)		
Not Significant	26 (26.0)	47 (47.0)	73 (73.0)		

χ^2 : Chi square test; F: Fisher's exact test; *: p value <0.05

DISCUSSION

The prevalence of left ventricular systolic dysfunction in the current study was 36% which was higher than the 33.7% reported by Okoromah *et al* in Lagos.⁷ The observed difference may be explained by the different diagnostic cut-off of fractional shortening used in the present study. It is also higher than the 27% reported by Arodiwe *et al* in Enugu.¹¹ The reason for the observed difference may be due to the fact that the prevalence in this study was among all the categories of HIV infected clients without stratification. The finding in this study is equally higher than the 26% reported by Badal *et al* in India.²⁴ The discrepancy may be due to time and geographical difference as this study is more recent and in Nigeria. The present study also excluded those with congenital heart diseases unlike the India study.

The left ventricular systolic dysfunction of 36% in the current study is similar to the

37% earlier reported among Thai children.²⁵ Similar diagnostic criteria was used and this may account for the similarity. Ige *et al* in Jos Nigeria however reported a higher prevalence of left ventricular systolic dysfunction of 50.0%.¹⁶ This may be due to the better immune status of subjects in the present study where more than three – quarter (79%) were at the early stage of the disease unlike the Jos study.

Using MPI, left ventricular dysfunction in this study was 46% but as stated earlier, this tool assesses both the left ventricular systolic and diastolic functions. More subjects with advanced HIV/AIDS had left ventricular systolic dysfunction, similar to earlier reports.^{11,16} This may be due to the established impact of HIV on the heart via direct cardiac invasion and toxicity, chronic inflammation, auto-immunity, malnutrition, chronic anaemia and effects of some drugs.²⁶⁻²⁹

Non-performance of viral load of the participants living with HIV, not routinely available at our center while doing this study, which could have helped in relating our findings to their viral suppression status as well as not relating it to the HAART they were on are draw backs in this study although they did not in any way invalidate the findings.

CONCLUSION

The prevalence of left ventricular systolic dysfunction is twice higher among children living with HIV. Most of the children living with HIV in this study were males, adolescents, at the asymptomatic phase, on HAART and belonged to the lower socio-economic status. We recommend routine screening of children living with HIV at the advanced stage of the disease for left ventricular systolic function using echocardiography.

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REFERENCES

1. Federal Republic of Nigeria. Overview of the Epidemics. In: Nigerian Action Against AIDS NACA (ed), Global AIDS Response: Country Progress Report. Abuja: GARPR. 2014:17-25
2. Olusegun-Joseph DA, Ajuluchukwu JNA, Okany CC, Mbakwem A, Oke DA. The Heart and HIV/AIDS. *Internet J Cardiol* 2009; 9(1)
3. Global HIV / AIDS Overview: The Global impact of HIV & AIDS. <https://www.hiv.gov/federal-response/pepfar-global-aids/global-hiv-aids-overview/> (Accessed: 4th December 2021)
4. UNAIDS Data 2020. Advancing towards the three zeros. Epub ahead of print 2021. Last updated 29th November 2021. www.unaids.org (Accessed: 4th December 2021)
5. Federal Ministry of Health. *Nigeria AIDS Indicator and Impact Survey 2018*. Available at <https://www.naiis.ng/resource/factsheet/NAIIS%20National%20Summary%20Sheet.pdf> (Accessed: 4th December 2021)
6. Sharma RK, Chavan V, Neki NS, Singh AP, Jaitwani J, Kumar H, et al. Study of cardiac manifestations in patients with HIV infection and their correlation with CD4 count in Indian population. *Ann Int Med Dent Res*. 2016; 3:4-11
7. Okoromah CAN, Ojo OO, Ogunkunle OO. Cardiovascular Dysfunction in HIV-infected Children in a Sub-Saharan African Country: Comparative Cross-sectional Observational Study. *J Trop Pediatr*. 2012; 58:3-11
8. Yogev R, Chadwick EG. Acquired Immunodeficiency Syndrome (Human Immunodeficiency virus). In: Kliegman RM, Behrman RE, Jenson HB, et al. (eds) *Nelson Textbook of Pediatrics* 18th Edition. Philadelphia: Saunders Elsevier. 2007; pp1427-1443
9. Sadoh WE. Cardiovascular abnormality in children with human immunodeficiency virus: Is there a need for cardiac screening? *Niger J Cardiol*. 2014; 11:1-2
10. Nagueh SF, Smiseth OA, Appleton CP, Byrd BF, Dokainish H, Edvardsen T, et al. Recommendations for the Evaluation of Left Ventricular Diastolic Function by Echocardiography: An update from the American Society of Echocardiography and the European Association of Cardiovascular imaging, *J Am Soc Echocardiogr*. 2016;

29:277-314

11. Arodiwe I, Ikefuna A, Obidike E, Arodiwe E, Anisuba B, Ibeziako N, et al. Left ventricular systolic function in Nigerian children infected with HIV / AIDS : a cross-sectional study. *Cardiovasc J Afr.* 2016; 27:25–29

12. Animasahun BA, Diaku-Akinwumi IN, Ubuane PO, Ibitoye E. Cardiac size and systolic function of HIV infected Lagos children accessing routine care: a pilot study. *J Xiangya Med.* 2018; 3:14-24

13. Medical Record Department. *Paediatric ART Clinic.* Ilorin, 2014 (Unpublished)

14. Statistics Division. *National Population Commission Kwara State.* 2001 (Unpublished)

15. Kamangar F, Islami F. Sample Size Calculation for Epidemiologic Studies: Principles and Methods. *Arch Iran Med.* 2013; 16: 295–300

16. Ige OO, Oguche S, Bode-Thomas F. Left Ventricular Systolic Function in Nigerian Children with Human Immunodeficiency Virus Infection. *Congenit Hear Dis.* 2012; 7:417–422

17. Lubega S, Zirembuzi GW, Lwabi P. Heart disease among children with HIV / AIDS attending the paediatric infectious disease clinic at Mulago Hospital. *Afr Health Sci.* 2005; 5:219–226

18. Klein-Gitelman MS, Miller ML. Systemic Lupus Erythematosus. In: Kliegman RM, Behrman RE, Jenson HB, et al. (eds) *Nelson Textbook of Paediatrics.* Philadelphia: Saunders Elsevier. 2007; pp1015–1019

19. Oyedeji G. Socio economic and cultural background of Hospitalised children in Ilesha. *Niger J Paediatr.* 1985; 12:111–117

20. Lai WW, Geva T, Shirali GS, Frommelt PC, Humes RA, Brook MM, et al. Guidelines and Standards for Performance of a Paediatric Echocardiogram: a report from the task force of paediatric council of the American Society of Echocardiography. *Echocardio. J Am Soc Echocardiogr.* 2006; 19:1413–1430

21. Lopez L, Colan SD, Frommelt PC, Ensing GJ, Kendall K, Younoszai AK, et al.

Recommendations for Quantification Methods During the Performance of a Pediatric Echocardiogram : a report from the Pediatric Measurements Writing Group of the American Society of Echocardiography Pediatric and Congenital Heart Disease Council. *J Am Soc Echocardiogr.* 2010; 23:465–495

22. Fryland M, Chaillet P, Zachariah R, Barnaba A, Bonte L, Andereassen R, et al. The Partec CyFlow Counter could provide an option for CD4+ T-cell monitoring in the context of scaling-up antiretroviral treatment at the district level in Malawi. *J Roy Soc Trop Med H.* 2006; 100:980–985

23. Fergenbaum H. Evaluation of Left ventricular Diastolic function. In: Armstrong WF, Ryan T (eds) *Fergenbaum's Echocardiography.* Philadelphia: Lippincott Williams and Wilkins. 2010; pp159–182

24. Badal S, Gupta R, Kumar P, Sharma M, Chhajta DS. Cardiac Manifestations in HIV Infected Children. Are they under Diagnosed? *HIV/AIDS Res Treat Open J.* 2015; 2:21–26

25. Pongprot Yupada, Sittiwangkul R, Silvilairat S, and Sirisanthana V. Cardiac manifestations in HIV - infected Thai children. *Ann Trop Paediatr.* 2004; 24:153–159

26. Bhardwaj A, Parikh R, Daoko J, Singh L, Shamoon FE, Slim J, et al. Cardiovascular Manifestation of HIV : Review. *J Antivirals Antiretrovir.* 2009; 1:11–16

27. Isiguzo GC, Okeahialam BN, Danbauchi SS, Odili AN, Iroezindu MO, Placid U, et al. Contributions of Pulmonary hypertension to HIV-related cardiac dysfunction. *Indian Heart J.* 2013; 65:644–649

28. Namuyonga J, Lubega S, Musiime V, Lwabi P, Lubega I. Cardiac dysfunction among HIV infected Ugandan Children on Antiretroviral therapy. *Pediatr Infect Dis J.* 2016; 35: 215–225

29. Ige O, Oguche S, Yilgwan C, Abdu H, Bode-Thomas F. The QT interval in human immunodeficiency virus - positive Nigerian children. *J Med Trop.* 2014; 16:61–65