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Research Paper

Echocardiographic Assessment of Cardiac Morphology among Professional Footballers in Southern Nigeria

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ABSTRACT
BACKGROUND: *Regular physical training in athletes causes adaptive structural and functional changes within the heart. These changes arise progressively and may regress upon interruption of the physical activity. These morphological and functional changes are referred to as the ''athlete's heart''. Sudden cardiac death is the most common medical cause of death in athletes. Electrocardiography (ECG) is recommended for pre-participation cardiac screening in athletes and an Echocardiography (ECHO) for those with abnormal ECG. There are however paucity of data on the pattern of echocardiographic changes among professional footballers in Nigeria*
OBJECTIVE: *To identify the echocardiographic changes in professional footballers during a pre-participation evaluation and those of non-athletes residing in Southern Nigeria*
METHODS: *It was a cross-sectional study of ECHO performed as pre-participation medical assessment for 40 male football players and 40 male non-athletes that were used as controls. Two-dimensionalmotion -mode and doppler ECHO were performed for all participants. The controls were matched for age, weight and height.Data obtained was analyzed using SPSS-25.*
RESULTS: *The mean age of the Athletes was 25.2± 3.5 years and the mean body surface area (BSA) was 1.88± 0.13.Echocardiographic changes were significantly higher in the professional footballers in comparison with the controls. The left inter ventricular septal wall thickness,left ventricular posterior wall thickness, left ventricular internal dimension in diastole,left ventricular mass index (LVMI),right ventricular dimensionsand left atrial dimension were significantly higher in the professional footballers than age-matched controls. Prevalence of left ventricular hypertrophy was (62.5% vs 12.5%, p <0.001 among footballers andcontrols respectively, with the commonest type of left ventricular geometry being eccentric Left ventricular hypertrophy in the athletes.*
CONCLUSION: *Echocardiographic findings of cardiac adaptationswere found in the professional footballers. These cardiac morphologic changes should be differentiated from pathological states and would also help identify those at risk of sudden cardiac death who will benefit from early definitive intervention.*
KEYWORDS: *Echocardiography, professional footballers, cardiac adaptations, Athlete's heart.*

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I. INTRODUCTION

The major cause of death of an apparently healthy athlete during exercise is due to sudden cardiac death (SCD)[1,2,3].Regular and intense exercise is beneficial but can lead to functional and morphological cardiovascular changes that is termed the 'athlete's heart'. The athletic heart syndrome is defined as a constellation of clinical, electrocardiographic and echocardiographic variants of normal found in well trained athletes who participate in sports requiring prolonged aerobic exercise training[4]. These findings include sinus bradycardia, atrioventricular conduction delay, systolic flow murmurs and cardiac chamber enlargement[4,5].

There has been an increase in the knowledge of athlete heart syndrome in recent years due to the advancement of echocardiography studies and cardiac imaging. Prolonged exercise results in physiological adaptation of the cardiovascular system with benign hypertrophy of cardiac mass, as well as physiological alterations of the circulatory system and cardiac morphology[6,7,8]. These changes of prolonged conditioning of exercise leads to cardiac remodeling which in turn will mimic certain structural or conductive defects of the heart resulting in SCD during strenuous activity[6,7,8]. A cardiac screening study conducted by Malhotra et al.

(2018) involving about eleven thousand teenage footballers revealed a 6.8 per 100,000 incidences of sudden cardiac death[9].

Echocardiographic assessment to determine cardiac morphological changes in professional footballers is vital to identify those at risk of SCD. Data on echocardiographic changes among professional footballers in Nigeria and other African countries are few. This study was carried out to identify the echocardiographic changes among professional footballers and comparing such findings with what is seen in non-athletes in Southern Nigeria, a developing West African country.

II. METHODOLOGY

The data was derived from a cross sectional comparative study design involving male athletes and non-athletes within the ages of 18 and 32 carried out at a private hospital in Port Harcourt, Rivers State. The athletes were professional footballers of the Rivers United FC, a Nigerian Professional Football League who were undergoing their pre- participation evaluation and had echocardiography as part of the investigations done. Forty members of the club and forty non-athletes normal males within the same age, height and weight bracket in the same vicinity had 2-dimensional (2-D), M-mode and Doppler echocardiography performed according to the American Society of Echocardiography (ASE) standardized protocols[10]. Their demographics and clinical parameters including age, weight, height, blood pressure (BP) and heart rate were taken. Parameters taken during echocardiography include left ventricular interventricular septal thickness is diastole (IVSd), left ventricular posterior wall thickness in diastole (PWd), left ventricular end diastolic dimension (LVEDD), left ventricular end systolic dimension (LVESD), left atrial dimension, right atrial dimension, ventricular dimensions and aortic root dimensions. Other parameters include trans-mitral and trans-tricuspid early (E) and late (A) diastolic flow and right ventricular wall thickness.

The left ventricular mass index (LVMI) was determined using the Devereux formula corrected for height[4]. Left ventricular hypertrophy (LVH) was defined as LVMI $>115 g/m^2$ and relative wall thickness (RWT) of > 0.42 for concentric hypertrophy and ≤ 0.42 for eccentric hypertrophy[11].

The data obtained were entered into Microsoft excel and exported to IBM SPSS version 25 for analysis. Descriptive tables were represented as Mean and standard deviation as well charts indicating frequencies and proportions. Inferential statistics was conducted using independent sample t test for numerical variables and chi square for categorical variables. P value of <0.05 was considered statistically significant. Informed consent was taken from all participants in the study.

III. RESULTS

The study involved the recruitment of 40 male athletes and 40 male non-athletes within the ages of 18 and 32 years.Table 1 shows the descriptive variables of the study participants. The mean age of the professional footballers is similar to that of the controls (25.00±3.5 vs 25.58±3.69, $p > 0.05$) as shown in Figure 1. The mean BMI, Systolic blood pressure (SBP), Diastolic blood pressure(DBP) and body surface area (BSA) were also similar between the two groups (23.73±1.45 vs 22.89±2.29, 121.83±13.99 vs 121.00±11.77, 76.69±12.21 vs 76.18±5.46, 1.88±0.13 vs 1.85±0.11)respectively, for professional footballers and controls, ($p > 0.05$). The heart rate was however lower in the athletes than in the controls with a mean of 51.69±2.36 vs 72.87±6.67, $p < 0.001$*. Table 2 shows comparison of the anthropometric variables among the athletes and control.

Table 1. Descriptive variables of the study participants

Variables	Mean ± SD	Range (Min-Max)
Age (years)	25.20 ± 3.57	18-32
Height (cm)	172.37 ± 6.95	161-188
Weight (kg)	66.30 ± 4.51	54-76
BMI (kg/m2)	23.43 ± 1.82	18.39-27.44
Systolic blood pressure (mmHg)	121.56 ± 13.19	96-160
Diastolic blood pressure (mmHg)	76.52 ± 10.43	60-100
Heart Rate (BPM)	62.14 ± 11.75	48-80

Table 2. Comparison of age and anthropometric variables among athletes and non-athletes

Variables	Groups		t test	p-value	CI	
	Cases (n=40) Mean ±SD	Control (n=40) Mean ±SD			Lower	Upper
Age	25.00±3.50	25.58±3.69	-0.558	0.580	-2.682	1.524
Height	169.54±6.44	168.37±6.14	0.682	0.499	-0.083	0.165
Weight	67.14±3.42	65.74±5.81	1.656	0.060	-0.587	5.399
BMI	23.73±1.45	22.89±2.29	1.426	0.166	-0.366	2.024
SBP	121.83±13.99	121.00±11.77	0.2224	0.824	-6.681	8.338
DBP	76.69±12.21	76.18±5.46	0.208	0.836	-4.417	5.435
Heart Rate	51.72±2.25	68.32±8.23	-8.624	0.001*	-20.615	-12.572

The mean left ventricular septal and posterior wall thickness, left ventricular internal dimension in diastole, left ventricular mass index (LVMI), right ventricular dimension and left atrial dimension were significantly higher in the professional footballers than age-matched controls ($p < 0.001$) as seen inTable 3. The mean trans-mitral early diastolic velocity (E) and mitral E/A ratio were significantly reduced among the footballers compared to the controls as shown in Table 3.

Table 3. Echocardiographic variables in athletes and non- athletes

Variables	Groups		t test	p-value	CI	
	Athletes (n=40) Mean ±SD	Non Athletes (n=40) Mean ±SD			Lower	Upper
Body Surface Area	1.88±0.13	1.85±0.11	0.432	0.0676	-0.066	0.180
LVEDD	5.43±0.49	5.02±0.35	4.218	0.0001*	0.109	0.599
ESD	3.36±0.32	3.22±1.14	0.430	0.672	-0.465	0.707
IVSd	1.12±0.23	0.922±0.23	3.798	0.0001*	0.093	0.301
PWd	1.11±0.17	0.86±0.17	6.478	0.0001*	0.172	0.325
LVDV	139.62±22.51	123.62±19.11	3.376	0.001*	6.557	25.407
LVSV	47.38±15.11	35.95±9.15	4.063	0.0001*	5.732	17.118
LVMI	124.05±22.28	88.22±12.80	8.419	0.0001*	27.346	44.228
EPSS	38.95±14.49	42.25±11.13	-1.092	0.281	-11.153	3.313
Fractional Shortening	38.66±6.28	39.90±3.59	-1.116	0.313	-4.377	1.258
Ejection Fraction	71.99±4.24	73.10±5.45	0.945	0.318	-1.566	4.338
E-wave	67.92±14.55	80.10±8.33	-4.028	0.0001*	-17.699	-6.574
A-wave	45.07±8.16	47.75±6.67	-1.267	0.116	-6.864	1.564
EA-ratio	1.55±0.39	1.69±0.21	-2.061	0.046*	-0.338	-0.003
Deceleration time	170.97±19.97	161.60±22.31	1.969	0.053	-0.109	18.858
E-septal	15.87±2.98	13.81±1.63	3.788	0.001*	0.978	3.178
E-lateral	18.48±3.70	16.17±1.56	3.506	0.001*	0.775	3.848
E/e^{l}	4.44±0.82	5.87±0.91	-7.252	0.001*	-1.924	-0.909
LA-diameter	3.63±0.33	3.41±0.31	3.342	0.001*	0.101	0.474
LA Area	16.34±2.19	13.72±1.84	3.778	0.0001*	1.692	3.533
LA Volume Index	25.94±4.11	19.34±4.17	4.832	0.0001*	2.609	9.187
RA-Area	15.29±3.19	11.64±1.43	6.063	0.0001*	2.447	4.810
IVC diameter	1.74±0.32	1.59±0.22	2.362	0.007*	0.027	0.340
Mid RV diameter	2.84±0.26	2.65±0.31	2.433	0.004*	0.034	0.383
RA Base to apex length	6.60±0.47	6.17±0.44	3.578	0.0001*	0.205	0.737
FAC	55.18±6.46	52.61±9.74	0.922	0.160	-2.854	7.530

TAPSE	25.70±2.77	24.08±3.24	1.602	0.022	-3.7	8.198
Systolic RV/RA gradient	17.85±10.59	15.00±5.67	0.794	0.688	-91.455	105.112
RV Free wall thickness	0.36±0.05	0.37±0.06	-0.759	0.746	-0.049	0.023
ARD	2.98±0.33	2.79±0.27	2.433	0.008*	0.036	0.385
Aorta Ascedens	2.76±0.24	2.60±0.25	2.971	0.006*	0.068	0.358

LVEDD= Left Ventricular End Diastolic Diameter; ESD= End Systolic Diameter; IVSd= Interventricular Septal Thickness in diastole; PWd= Left ventricular Posterior Wall Thickness in diastole; LVDV= Left Ventricular Diastolic Volume; LVSV= Left Ventricular Systolic Volume, ;LVMI-=Left ventricular mass indexEPSS= End point septal separation, FAC= Fractional Area Change; TAPSE= Tricuspid Annular pulmonary systolic excursion; Systolic RV= Systolic Right Ventricular/Right Atria Gradient; ARD= Aortic Root Diameter; LVMI= Left Ventricular Mass Index.

Thirty-five (87.5%) of the non-athletic study participants had a normal echocardiography and five (12.5%) had abnormal findings. However, among the athletes, 15% had abnormal ECHO, 35% had a normal ECHO and 50% had findings that were consistent with adaptive changes due to the prolonged training and exercise (Figure 1). The proportion of participants with LVH diagnosed with ECHO was significantly higher among professional footballers compared to normal controls (62.5% vs 7.5%, p < 0.05). Figure 2 shows the ventricular geometric changes in athletes and controls. Chamber dilatation including LVEDD > 50mm and right ventricular dimension of > 28 mm were also significantly commoner among the footballers than controls (87.5 vs 60.0%, 57.5 vs 35.0%, p <0.005*). In this study a Left atrial diameter of > 40 mm and aortic root diameter of > 35 mm were found in 7.5% and 5% of the professional footballers and none in the controls as shown in Table 4. The ejection fraction and fractional shortening were higher, but not statistically significantamong the athletes compared with the controls (71.99±4.24 vs73.10±5.45), 38.66±6.28 vs 39.90±3.59 respectively, p >0.05). One of the athletes had impaired left ventricular systolic function (EF of 28%)

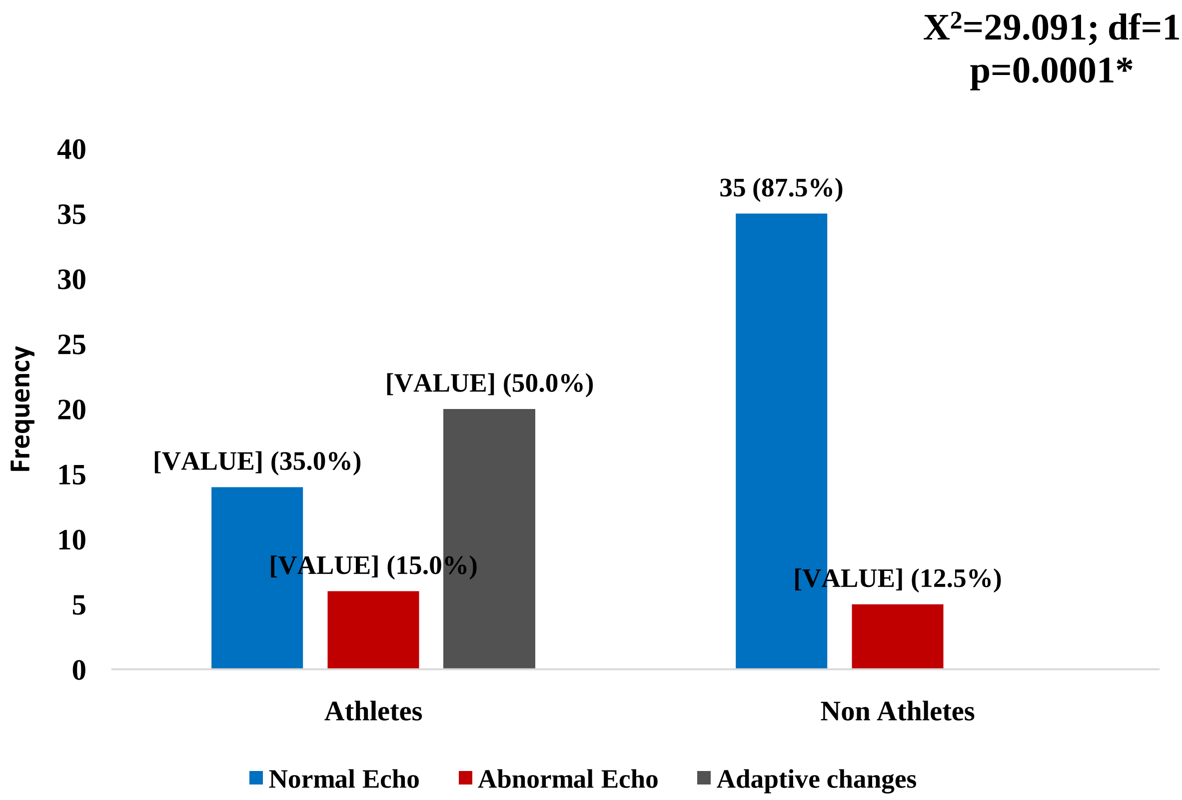
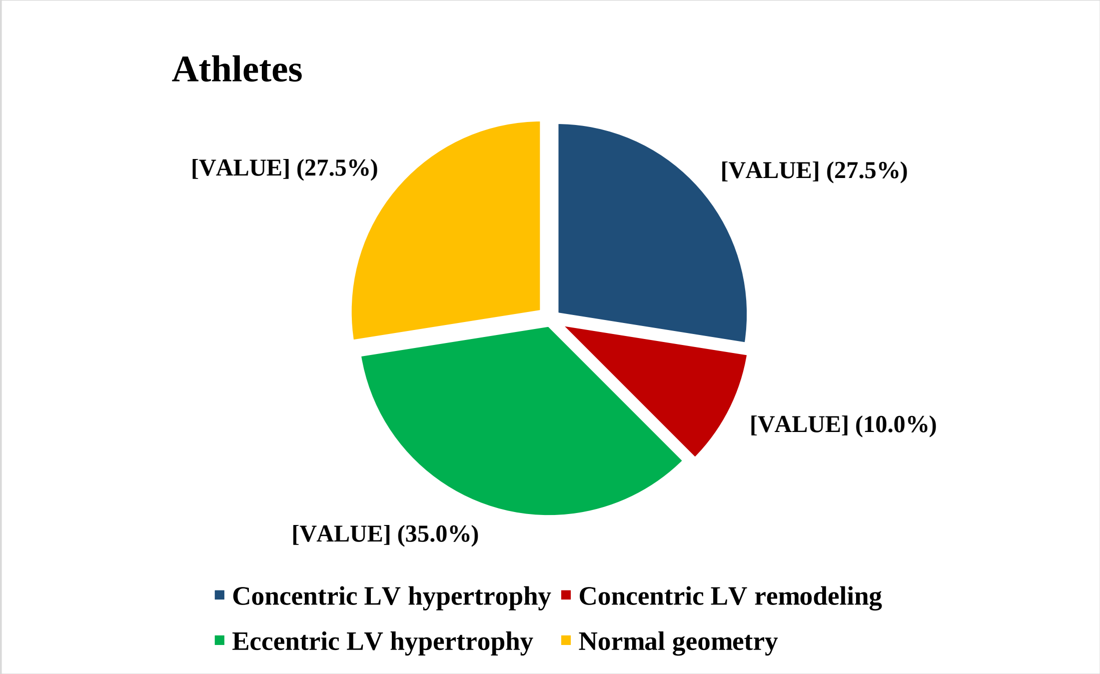


Figure 1. Comparison of Echo summary among athletes and controls



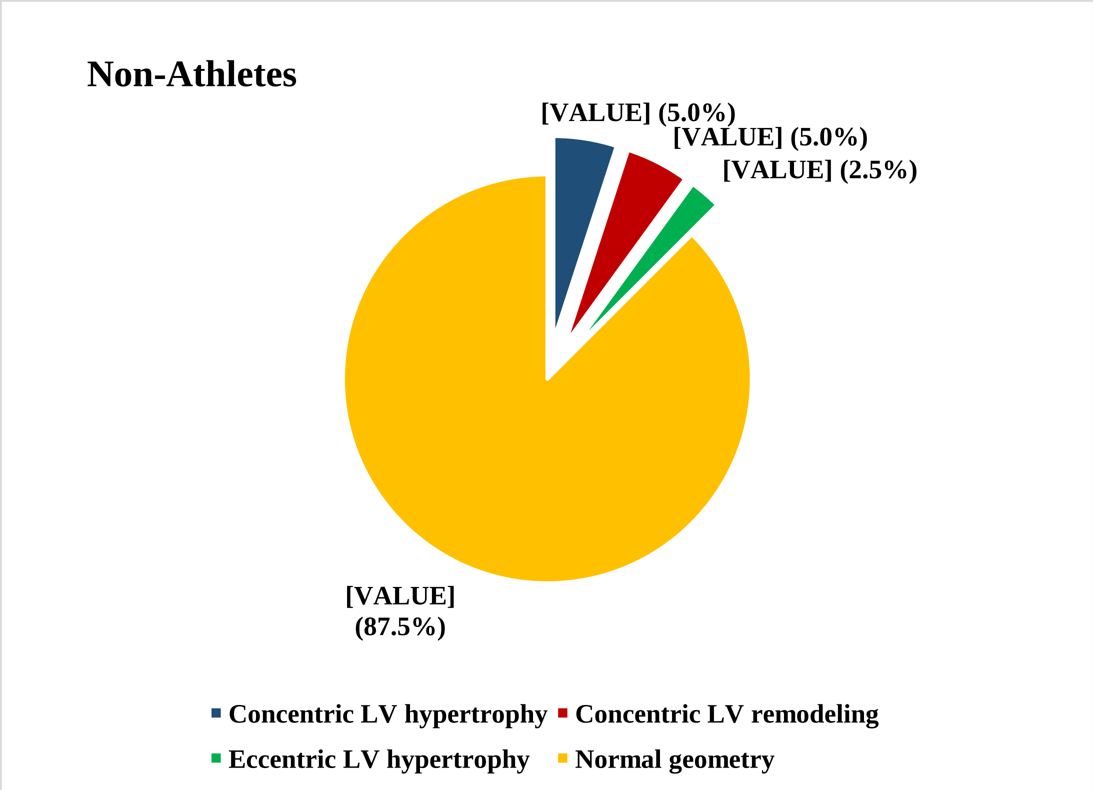


Figure 2. Pattern of left ventricular geometry among athletes and non-athletes.

Table 4. Pattern of echocardiographic adaptation among study participants

Variables	Athletes (n=40) (%)	Non-Athletes (40) (%)	P value
LVH	25 (62.5)	3 (7.5)	0.0001*
LVDD (>50mm)	35 (87.5)	24 (60.0)	0.005*
RVD (>28mm)	23 (57.5)	14 (35.0)	0.044*
AOD (>35mm)	3 (7.5)	0 (0.0)	0.077

LAD (>40mm)	2 (5.0)	0 (0.0)	0.152

IV. DISCUSSION

There is paucity of data on cardiac adaptations among professional footballers in Nigerian athletes. This study showed that regular and intense exercise is associated with significant echocardiographic cardiac morphologic changes among professional footballers in Nigeria. These morphological changes include increased left ventricular mass index and increased cardiac chamberdimensions, among others. Churchill et al also noted incremental age dependent increase in left ventricular mass and wall thickness in athletes which may suggest that exercise induced remodeling as was seen in this studyis an ongoing process as long as one remains an athlete.[12] Theprofessional footballers as a result of cardiac adaptation to long term exercise had a significantly higher left ventricular internal dimensions in diastole, mean interventricular septal thickness in diastole, mean left ventricular posterior wall thickness in diastole, mean left and right atria dimensions and mean right ventricular internal dimension than the controls. Adeseye et al reported similar findings in their study among professional footballers in Nigeria[13]. This agrees with studies among other African athletes that have documented increased dimensions among sportsmen and women[14, 15]. Studies among Caucasians have also corroborated these findings[16,17,18] Eccentric left ventricular hypertrophy(LVH) was the commonest type of left ventricular geometry noticed in our study accounting for35% of athletes which was similar to what was found by Churchill et al where 41% of the athletes had eccentric LVH in their study of male and female football players. Eccentric LVH is associated with adaptation pf the heart to endurance training resulting in increased LV internal diameter as the heart adapts to increased volume load and increase in LV wall thickness[19].

Farnaza A et al in their echocardiography study among Malaysians footballers identified two footballers with asymptomatic apical hypertrophic cardiomyopathy (HCM) which is a known cause of sudden cardiac death in athletes[20].In our study we had 8 athletes with interventricular septal thickness (IVSd) of >13mm but no athlete with IVSd>15mm or suggestive of hypertrophic cardiomyopathy. This study however found an athlete with myocarditis and reduced left ventricular ejection fraction of 28.5% which would not have been noticed without echocardiography. This reduced ejection fraction found in one of the athletes is not commonly seen in athletes and there was no significant difference in the mean ejection fraction of the athletes and control.Athletes usually have structural or anatomic and not functional adaptive changes as seen in several studies[12, 13, 21]. Echocardiography and other forms of cardiac imaging among professional footballers can assist in detecting pathological structural defects that can be mistaken for physiologic cardiac adaptations due to prolonged engagement in moderate to intense physical activities that is seen in athletes,and this can be a preventive measure in reducing sudden cardiac death among athletes.

V. CONCLUSION

Echocardiography is vital in identifying cardiac morphologic changes consistent with physiologic adaptations observed in high level athletes. Professional footballers in southern Nigeria had significant echocardiographic cardiac adaptations and these included increased chamber dimensions, left ventricular wall thickness and ventricular chamber hypertrophy.These cardiac adaptations though benign, require strict and regular follow up to monitor the progression of these adaptive changes to detectany pathological states. Referral for early intervention would thus prevent sudden cardiac death during intense exercise.

REFERENCES

[1]. Harmon KG, Asif IM,Klossner D,&Drezner JA (. Incidence of sudden cardiac death in National Collegiate Athletic Association athletes. Circulation 2011;123(15): 1594-600.

[2]. Maron B J, Haas TS, Ahluwalia A. Demographics and Epidemiology of Sudden Deaths in Young Competitive Athletes: From the United States National Registry. Am J Med.2016; 129(11):1170-1177.

[3]. Maron BJ, Doerer JJ, Haas TS. Sudden deaths in young competitive athletes: analysis of 1866 deaths in the United States 1980-2006. Circulation 2009; 119(8): 1085-1092.

[4]. Rost R. The athletes' heart. Historical perspectives-solved and unsolved problems. Cardiol Clin 1997; 15:493-512.

[5]. Thomas LR, Douglas PS. Echocardiographic findings in athletes. In: Thompson PD, editor. Exercise and sports cardiology. New York: Oxford University Press; 1986.

[6]. Maron BJ. Sudden death in young athletes. N Engl J Med. 2003;349: 1064-1075.

[7]. Maron BJ, Pelliccia A, & Spirito P. Cardiac disease in young trained athletes: insights into methods of distinguishing athlete's heart from structural heart disease; with particular emphasis on hypertrophic cardiomyopathy. Circulation 1995;91: 1596-1601.

[8]. Morganroth J, Maron BJ, Henry WL, & Epstein SE. Comparative left ventricular dimensions in trained athletes. Ann Intern Med. 1975;82: 521-524.

[9]. Malhotra A, Dhutia H, Finocchiaro G. Outcomes of Cardiac Screening in Adolescent Soccer Players. Engl J Med, 2018; 379(6):524-534.

[10]. Schiller NB, Shah PM, Crawford M, Demaria A, Deveruex R, Feigenbaum H, et al. Recommendations for quantification of the left ventricle by two-dimensional echocardiography. American Society of Echocardiography Committee on standards. Subcommittee on Quantification of Two- Dimensional. J Am Soc Echocardiogr 1989;2:358-367.

[11]. Devereux RB, Alonso DR, Lutas EM, Gottlieb GJ, Campo E, Sachs I et al. Echocardiographic assessment of left ventricular hypertrophy: comparison to necropsy findings. Am J Cardiol 1986; 57: 450-458.

[12]. Churchill TW,Petek BJ, Wasfy MM, Gusch JS, Weiner RB, Singh TK, Schmied C. Cardiac Structure and function in elite female and male soccer players. Jama Cardiol. 2021; 6:316- 325

[13]. Adeseye AA, Lookman KO. Structural and functional adaptations to exercise: Echocardiographic findings among professional footballers on routine screening among Nigerians- A view of athletes' heart. Nig J Cardiol 2015; 12: 111-114.

[14]. Pambo P, Adu-Adadey M, Ankrah PT, Agbodzakey H, Scharhag J. Electrocardiographic and Echocardiographic Findings in Ghanaian Female Soccer Players. Clin J Sport Med. 2020; 1-6.

[15]. Sangaré I, Bâ HO, Camara Y, Menta I, Mété R, Sidibé N, et al. ECG and Echocardiography Findings: A Comparative Study between Sportive and Sedentary Female Patients (Bamako, Mali). World J Cardio Dis. 2019; 9: 458-466.

[16]. Pelliccia A, Culasso F, Di Paolo FM, Maron BJ. Physiologic left ventricular cavity dilatation in elite athletes. Ann Int Med 1999; 130: 23-31.

[17]. D' Andrea A, Limongelli G, Caso P, Sarubbi B, Della Pietra A, Braancaccio P, et al. Association between left ventricular structure and cardiac performance during effort in two morphological forms of athletes heart. Int J Cardiol 2002; 86: 177-184.

[18]. D' Andrea A, Riegler L, Cocchia R, Scarafile R, Salerni G, Gravino R et al. Left atrial volume index in highly trained athletes. Am Heart J 2010; 159: 1155-1161.

[19]. Pluim BM, Zwinderman AH, Van der Laarse A, Van der Wall E. The Athletes heart. A Meta- Analysis of Cardiac structure and function. Circulation 2000; 101:336-344

[20]. Farnaza A, Rizmy NK, Mohamed-Syarif M, Noorhida B, IIham AI, Hasidah A, HaizIene A et al. Identifying electrocardiogram pattern changes and their association with echocardiography among Malaysian footballers attending pre-participation evaluation. Journal of Clinical and Health Sciences; 5(1): 49.

[21]. Engvall JE, Aneq MA, Nylander E, Budin L, Maret E. Moderately trained male football players compared to sedentary male adults exhibit anatomical but not functional cardiac remodeling a cross sectional study. Cardiovascular ultrasound 2021; 19:36