Cardiology and Angiology: An International Journal

9(3): 8-17, 2020; Article no.CA.57192
ISSN: 2347-520X, NLM ID: 101658392

Electrocardiographic and Echocardiographic Findings in Patients Older than 60 Years: A One Year Pilot Study

Ajala Aisha Oluwabunmi[1*] and Bell-Gam Hope Ilanye[2]

[1]Department of Internal Medicine, University of Port Harcourt Teaching Hospital, Rivers State, Nigeria.
[2]Geriatric Unit, Department of Internal Medicine, University of Port Harcourt Teaching Hospital, Rivers State, Nigeria.

Authors' contributions

This work was carried out in collaboration between both authors. Author AAO and BGHI designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author AAO performed the electrocardiogram, echocardiogram and managed the literature searches author BGHI managed the analyses of the study. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/CA/2020/v9i330135
Editor(s):
(1) Prof. Francesco Pelliccia, University La Sapienza, Italy.
Reviewers:
(1) Akinlade Olawale Mathias, Lautech Teaching Hospital, Nigeria.
(2) Raymond N. Haddad, Hotel Dieu de France University Medical Center and Saint Joseph University, Beirut, Lebanon.
Complete Peer review History: http://www.sdiarticle4.com/review-history/57192

Original Research Article

Received 09 March 2020
Accepted 13 May 2020
Published 23 May 2020

ABSTRACT

Background: Cardiovascular disease (CVD) is the most frequent diagnosis in elderly people and is the leading cause of death in both men and women older than 65 years of age. Age-related vulnerability to CVD is compounded by the cumulative effect of the normal aging process and cardiovascular risk factors over a lifetime. The study assessed the prevalence of electrocardiographic and echocardiographic abnormalities in patients older than 60 years at the geriatric unit of the University of Port-Harcourt Teaching Hospital.
Methods: A cross-sectional study was conducted over 50 patients admitted to the geriatric ward over one year. The subjects underwent blood pressure and anthropometric parameters clinical examinations. Evaluation of the cardiovascular system was done using resting electrocardiogram and echocardiography.
Results: The mean age of the subjects was 68.3±6.3 years with a female preponderance. Out of the 50 studied patients, 44 were admitted with a diagnosis of heart failure (HF). Preserved ejection

**Corresponding author: E-mail: ajalabunmi@gmail.com;*

fraction was present in 27 out of the 44 patients admitted for HF. Forty-seven patients had an abnormal LV geometry ranging from concentric remodeling to eccentric LV hypertrophy. Diastolic dysfunction was present in majority of the respondents 42 (84%). Resting ECG showed varying degrees of rhythm disturbances. Sinus tachycardia, bradycardia and left anterior fascicular blocks were the most prevalent rhythm disorders. Electrocardiographic LVH and left atrial abnormalities were present in 21 and 27 patients respectively. Prolonged QTc was present in only 4 patients.
Conclusion: Electrocardiographic and ultrasound abnormalities are common in elderly patients and this also reflects the high prevalence of CVD in these groups of patients. Thus, resting ECG and ultrasound should routinely be incorporated as one of the baseline assessments for elderly patients to identify potentially serious heart conditions and also serves as a basis for comparison during subsequent hospitalization.

Keywords: Elderly; cardiovascular disease; ECG; echo; Nigeria.

1. INTRODUCTION

Old age has been agreed upon by the United Nations and set at a cut off of 60 years [1]. The World Health Organization has suggested that the chronological age of 50 years seems to correlate with the conditions present in a developing continent like Africa. However, Nigerians mostly agree upon the criteria used to define old age in the developed world [2,3].

A lot of research literature exists on the effects of aging on the heart. Lakatta et al. [4] demonstrated that decreased vascular compliance altered the normal arterial structure as age increased; a concept which may singularly explain the isolated systolic hypertension in older people [5,6] Increasing age also comes with more cardiovascular risk factors. In Nigerian patients, a sedentary lifestyle, [7,8] poor feeding habits, unhealthy diet choices, [9, 10] hypertension, obesity, and dyslipidemia [11, 12] are amongst the leading risk factors for cardiovascular disease.

In poor resource settings like Nigeria, Patients' assessment includes taking a proper history, clinical examination, and basic routine testing. echocardiogram or electrocardiograms are considered luxuries rather than necessities in old people and are not routinely incorporated into patients' clinical assessments. However, In the developed world, there is increased use of echocardiography and electrocardiography in old people possibly due to previous research [13,14] showing that cardiac abnormalities could result from any of multiple pathologies present in old age and that early diagnosis of cardiac disease in the elderly is beneficial to help curb complications, institute intervention strategies early, and improve the quality of life.

Echocardiography is a useful tool in diagnosing a host of cardiac abnormalities such as valvular heart diseases and determining the underlying pathology especially in cases of heart failure [l5]. This cannot be definitively done with the use of clinical examinations as much as it would be if a cardiac imaging investigation such as an echocardiogram is added to support the clinical findings in these patients [15]. An assessment of common pathologies present in old people may make physicians more inclined to encourage older people to have a routine ECG or ultrasound assessment. Published evidence exists for their necessity routinely but knowledge of pathologies in this age group could enhance geriatric care through specific goal-oriented diagnostic testing that will be a very useful adjunct to history taking and clinical examinations in this group of patients. This study aims to determine the pathologies present on echocardiographic and electrocardiographic assessments of old people attending the University of Port Harcourt Teaching Hospital Geriatric care unit.

2. METHODOLOGY

2.1 Study Sample

Fifty consecutive Adults aged 60 years or more and attending the Geriatric Unit of the University of Port Harcourt Teaching Hospital (UPTH), Port Harcourt, Nigeria met the study inclusion criteria. All patients irrespective of the presence or absence of hypertension or other cardiovascular diseases or comorbidities were recruited for the study.

2.2 Echocardiogram Measurements

All patients had Trans-thoracic echocardiography done using a mobile Sonoscape S8 machine equipped with a 2.5 Hz cardiac probe. A Cardio-M Medical Econet® machine was used to do the 12- lead ECG and all evaluation was done at the geriatric unit in UPTH. Each subject was briefed on the non- invasive nature of the procedure to

allay fear and anxiety. The ECG parameters including LVH left or right atrial abnormalities, rhythm disturbances, QT interval prolongation, ST-T abnormalities, and presence of pathological Q waves were assessed and reported according to the Minnesota code for interpretation of ECG abnormalities.

Two- dimensional (2D), M-mode, pulse-wave, continuous-wave and color Doppler echocardiography assessment was done with the subject in the left lateral decubitus position and targeted echocardiographic estimations were taken using the internal analysis software of the machine. Two - Dimensional Oriented Motion – mode measurements of left atrial diameter (LAD), aortic size (AO), interventricular septal thickness in diastole (IVSd), left posterior wall thickness in diastole (LVPWd), and left ventricular end-diastolic diameter (LVEDd) just beyond the tips of the mitral valve leaflets were obtained from the parasternal long-axis view according to the American Society of Echocardiography Guidelines. Left ventricular mass in grams was calculated using the American Society of Echocardiography formula modified by Devereux.

$$LVM\ (gm) = 0.8 \times [1.04\ (LVIDd + PWDd + IVSDd)^3 - LVIDd^3] + 0.6g$$

Left ventricular mass was indexed to body surface area using cut-off values of 115 g/m2 and 95 g/m2 for men and women respectively. Relative wall thickness was also calculated as 2 × posterior wall thickness in end-diastole divided by LV end-diastolic diameter. A partition value of 0.42 for RWT was used for both men and women. The left ventricular diastolic pattern was assessed by Echo pulsed Doppler analysis according to the American Society of Echocardiography and European Association of Cardiovascular Imaging Guidelines. The diastolic mitral flow assessed by early diastolic peak velocity (E), the ratio of E to A (E/A) and the deceleration time of the early mitral velocity were recorded with the sample volume at the mitral leaflet tips.

2.3 Data Analysis

Data obtained were entered and analyzed using the International Business Machines - Statistical Product and Service Solutions version 20.0 (IBM - SPSS). Categorical data were presented as frequencies and percentages while continuous data were presented as means and standard deviations. Categorical data were compared using the chi-square test, while continuous data were compared using the independent t-test. A p-value of 0.05 was set as the significant level for all statistical comparisons made.

3. RESULTS

The mean age (SD) of respondents in the study was 68.3 (6.3) years. There were more females than males in the study (F: M ratio = 2.3:1). Out of the 50 studied subjects, 34 respondents were between the ages of 60 and 70 years while 16 subjects were aged 71 years and above as shown in Table 1.

Cardiovascular indices assessed by gender showed a significantly higher mean diastolic blood pressure in females when compared to their male ($p = 0.011$) as shown in Table 2.

Another comparison of cardiovascular indices by age group showed no significant differences in all parameters between patients aged 60 to 70 years of age when compared to those aged 71 years and above as shown in Table 3.

Forty- four (88%) of the subjects were diagnosed to have heart failure using the Framingham criteria with the majority, 27 (61.4%) being managed for heart failure with a preserved ejection fraction (HFpEF) as shown in Fig. 1.

Echocardiographic findings showed only three out of all the studied subjects had a normal left ventricular geometry (NG). Most of the patients studied had either Concentric Hypertrophy (CH) or Eccentric Hypertrophy (EH) as shown in Fig. 2.

Table 1. Socio-demographic distribution of subjects

Variable	Frequency (n =50)	Percentage (%)
Gender		
Male	15	30.00
Female	35	70.00
Age group		
60 – 70	34	68.00
71 and above	16	32.00
Mean age ±SD	***68.3±6.3***	

Table 2. Average cardiovascular indices by gender

Variable	Female	Male	T-test (p-value)
Systolic BP	126.4±19.6	121.8±24.4	0.4880
Diastolic BP	72.0±9.5	64.4±9.1	0.0108*
AVD	1.8±0.2	1.6±0.3	0.1459
AODd	2.6±0.5	3.0±0.5	0.0343*
E	95.2±27.3	83.6±33.1	0.2037
A	56.9±21.3	46.3±19.1	0.1038
E/A	1.9±0.7	2.1±1.3	0.4332
QTC	426.0±20.3	441.4±25.0	0.0268*
EDV	156.5±63.4	148.4±43.5	0.6554
ESV	97.9±79.3	100.1±58.1	0.9249
SV	58.1±24.6	47.9±27.2	0.2000
EF	61.1±16.5	57.2±16.6	0.4525
FS	31.0±9.8	29.2±8.6	0.5456
IVSD	1.1±0.2	1.2±0.3	0.6293
LVIDd	5.4±0.7	5.4±0.7	0.8977
LVM(g)	292.5±137.4	293.5±135.2	0.9819
LVMI(g/m^2)	165.5±70.9	166.8±69.1	0.9506
LAD	4.3±0.7	4.5±0.7	0.4806
TAPSE	1.7±0.3	1.7±0.4	0.6226
LVPWd	1.2±0.2	1.2±0.3	0.8872
RWT	0.4±0.1	0.4±0.1	0.8462

**Difference is statistically significant ($p < 0.05$)*

Table 3. Average cardiovascular indices by age group

Variable	60 – 70 years	≥71 years	T-test (p-value)
Systolic BP	123.0±22.5	129.3±17.2	0.3249
Diastolic BP	71.2±9.2	66.7±11.1	0.1417
AVD	1.7±0.2	1.8±0.2	0.3204
AODd	2.8±0.5	2.6±0.6	0.4094
E	90.5±30.6	94.2±27.1	0.6818
A	55.2±21.2	50.5±20.9	0.4753
E±A	1.9±1.0	2.1±0.9	0.4796
EDV	150.2±54.2	162.1±65.9	0.5061
ESV	94.9±69.3	106.4±82.1	0.6083
SV	54.9±26.3	55.3±24.8	0.9606
EF	59.9±16.1	60.1±17.8	0.9809
FS	31.1±8.8	29.5±10.9	0.6065
IVSD	1.1±0.3	1.1±0.2	0.8576
LVIDd	5.4±0.7	5.5±0.8	0.6690
LVM	286.7±133.9	305.8±141.9	0.6474
LVMI	164.8±68.1	168.1±74.9	0.8764
LAD	4.5±0.7	4.2±0.8	0.2556
TAPSE	1.7±0.3	1.8±0.4	0.1847
LVPWd	1.2±0.2	1.2±0.2	0.9774
RWT	0.4±0.1	0.4±0.1	0.7090

Difference is not statistically significant ($p > 0.05$) for all parameters

Diastolic dysfunction was present in the majority of subjects 42 (84%). Twenty patients had a grade 1 diastolic dysfunction (40%) while 12 (24%) had grade 2 diastolic dysfunction with 8 patients each having grade 3 diastolic dysfunction and normal diastolic function respectively (Fig. 3).

The aortic root dimension was significantly higher in the male subjects compared with the females

(p = 0.034). Valve dysfunction abnormalities noted to be present in this study were aortic regurgitation 6 (12%), aortic stenosis 2 (4%), mitral regurgitation 12 (24%) and tricuspid regurgitation 9 (18%), Pericardial effusion (PE) ranging from mild to moderate was present in 23 patients (19 mild PE vs 4 moderate PE) as shown in Table 4.

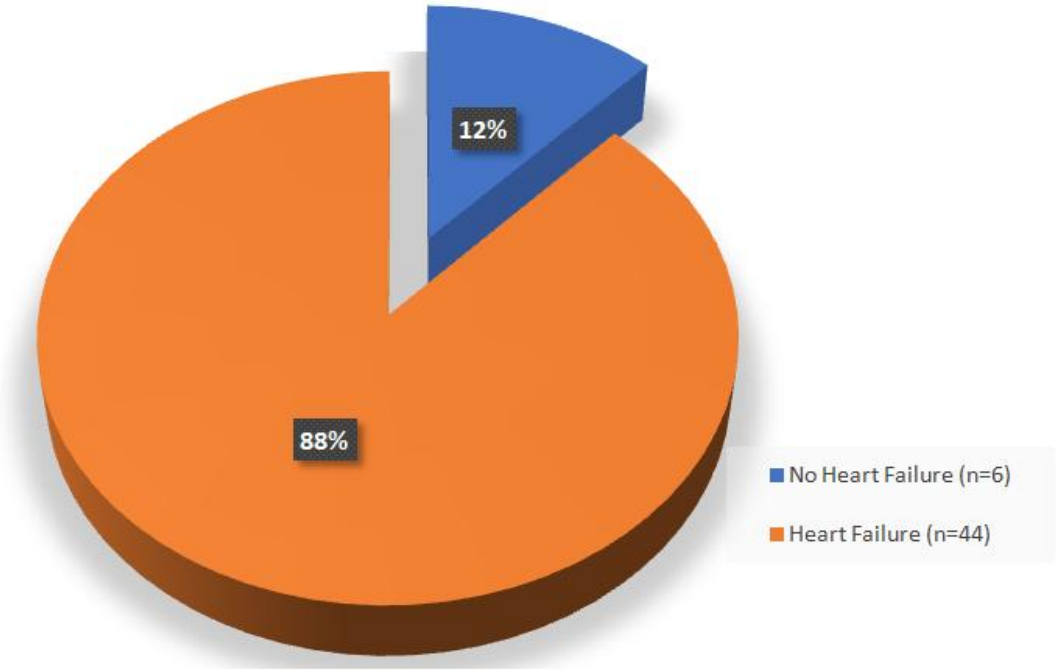

Fig. 1. Frequency of heart failure by Farmingham's criteria

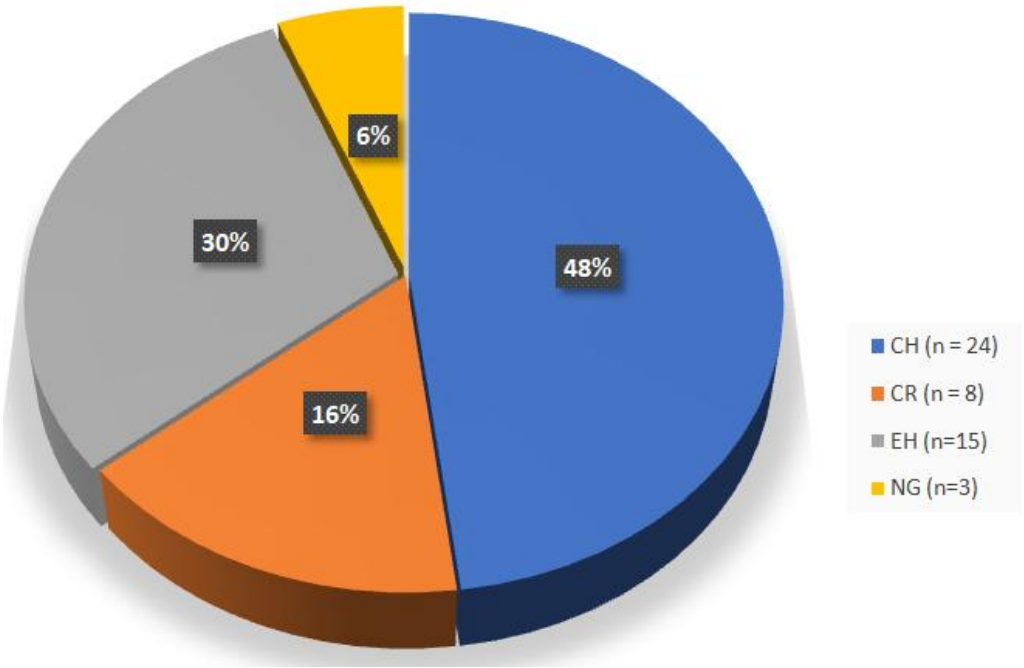

Fig. 2. Distribution of ventricular geometry

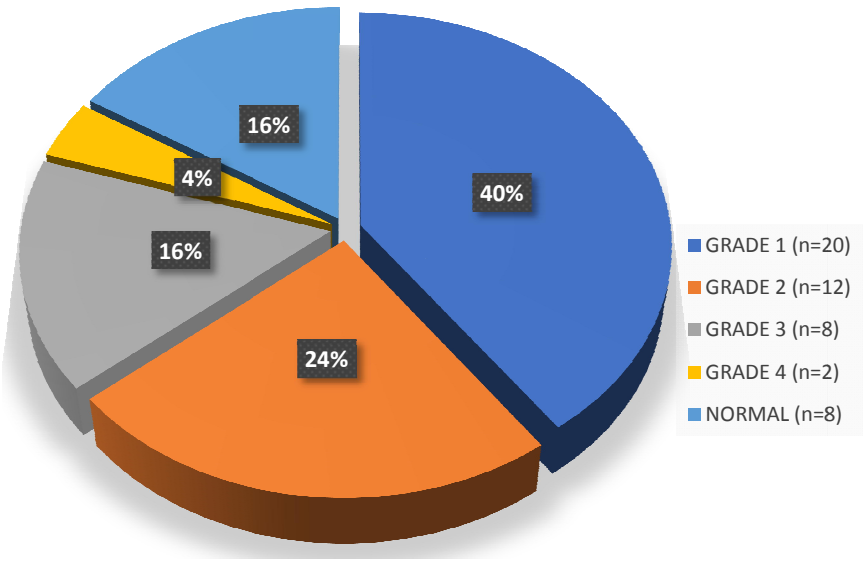

Fig. 3. Distribution of diastolic dysfunction

Table 4. Distribution of valve dysfunction abnormalities

Valve dysfunction	Frequency	Percent
AR	3	6%
AS	2	4%
MR	3	6%
MR/TR	4	8%
MR/TR/AR	5	10%
None	33	66%
Total	**50**	**100%**

AR: Aortic Regurgitation, AS: Aortic Stenosis, MR: Mitral Regurgitation, TR: Tricuspid Regurgitation

Tables 5 shows electrocardiographic left atrial enlargement and left ventricular hypertrophy were present in 27 and 21 patients respectively and both had a higher occurrence in females and amongst patients aged 60 to 70 years. There was no statistically significant difference in comparison of left atrial enlargement between gender and between both age groups (p = 0.19 and 0.15 respectively). Left ventricular hypertrophy and ejection fraction also showed no statistically significant difference when compared between both groups of age and gender (p =0.14 and 0.53 respectively).

Table 5. LAE and LVH distribution by age groups and gender

Variables	LAE		LVH	
	YES	NO	YES	NO
Age groups				
60 – 70 (n=34, %)	19 (55.88)	15 (44.12)	20 (58.82)	14 (41.18)
≥71years (n = 16, %)	8 (50.0)	8 (50.0)	1 (6.25)	15 (93.75)
Chi-Square (p-value)	*0.15 (0.6970)***		*12.34 (0.0004)**	
Gender				
Female (n=35, %)	21 (60.0)	14 (40.0)	14 (40.0)	21 (60.0)
Male (n = 15, %)	6 (40.0)	9 (60.0)	7 (46.7)	8 (53.3)
Chi-Square (p-value)	*1.69 (0.1934)***		*0.19 (0.6616)***	

Table 6. Distribution of rhythmic dysfunction by gender

Rhythm DIS	Female	Male	Chi-square (p-value)
1st degree A-V Block	0 (0.0)	6 (40.0)	15.90 (0.0001)*
3rd degree A-V Block	1 (2.9)	0 (0.0)	0.43 (0.5084)
Atrial fibrillation	2 (5.7)	0 (0.0)	0.89 (0.3447)
Sinus Bradycardia	6 (17.1)	0 (0.0)	2.92 (0.0873)
Left anterior fascicular block	1 (2.9)	6 (40.0)	12.03 (0.0005)*
Normal	3 (8.6)	1 (6.7)	0.05 (0.8200)
Premature atrial complexes	0 (0.0)	1 (6.7)	2.38 (0.1228)
Right bundle branch block	6 (17.1)	0 (0.0)	2.92 (0.0873)
Sinus Tachycardia	10 (28.6)	1 (6.7)	2.93 (0.0866)
Total	**29 (100.0)**	**15 (100.0)**	

**Difference is statistically significant (p < 0.05)*

Table 7. Distribution of rhythmic dysfunction by age-group

Rhythm DIS	60 - 70 years	≥71years	Chi-square (p-value)
1st degree A-V Block	6 (17.6)	0 (0.0)	3.20 (0.0735)
3rd degree A-V Block	1 (2.9)	0 (0.0)	0.48 (0.4883)
Atrial fibrillation	0 (0.0)	2 (12.5)	4.42 (0.0353)*
Sinus Bradycardia	5 (14.7)	1 (6.3)	0.73 (0.3907)
Left anterior fascicular block	6 (17.6)	1 (6.3)	1.17 (0.2786)
Normal	3 (8.8)	1 (6.3)	0.09 (0.7543)
Premature atrial complexes	0 (0.0)	1 (6.3)	2.16 (0.1408)
Right bundle branch block	6 (17.6)	0 (0.0)	3.20 (0.0732)
Sinus Tachycardia	7 (20.6)	4 (25.0)	0.12 (0.7253)
Total	**34 (100.0)**	**10 (100.0)**	

**Difference is statistically significant (p < 0.05)*

The QTc interval was significantly higher in females compared to their male counterparts (p = 0.023). The commonest rhythm disorders were sinus tachycardia, bradycardia, and left anterior fascicular blocks at 28.6%, 14%, and 17.1% respectively. Other rhythm abnormalities seen were atrial and ventricular ectopic and right bundle branch blocks, atrial fibrillation, and Atrioventricular blocks. Atrial fibrillation was reported in 2(4%) of the studied subjects and this was exclusively seen in the subjects aged 71 and above as shown in Tables 6 and 7.

4. DISCUSSION

Increasing age is a background for the development of cardiovascular disease and heart failure although not a direct cause of it [16]. Age-related changes result in vascular wall thickening, left ventricular wall hypertrophy and diastolic dysfunction all resulting from an increase in size and number of cardiac smooth muscle [17-20] leading to significant changes in diastolic function [21]. This may account for why the majority of patients in this study had diastolic dysfunction, left ventricular hypertrophy, and left atrial enlargement.

Old age is also associated with slower atrial filling due to reduced compliance of the left ventricle with impaired relaxation during diastole notable on echocardiography [22]. Besides, the presence of diastolic dysfunction in the absence of systolic dysfunction accounts for the prevalent type of heart failure commonly seen in the elderly [23]. Thus, the finding of a higher number of older people with heart failure with preserved ejection fraction in this study is comprehensible.

Aortic stenosis is the commonest valvular heart disease in older people attributable possibly to increase longevity [24]. Valvular heart abnormalities tend to occur in older age groups as well as young patients even in newborns (from congenital etiologies mostly). The etiology of valvular abnormalities in the elderly is mainly due to degenerative causes. There are also very little gender dissimilarities in the occurrence of valvular abnormalities save for a few cases such as rheumatic mitral stenosis which is more

prevalent in women [25]. Although absent in this study. Furthermore, the risk factors for valvular heart diseases are similar to those for other cardiovascular disorders (sedentary lifestyle, obesity, and dyslipidemia) which are associated with increasing age [16,17,26].

The severity of valvular heart disease also worsens with age [26] and its diagnosis using cardinal clinical features may be difficult as eliciting the symptoms in this group of patients is challenging making the use of diagnostic adjuncts such as echocardiography beneficial [27] Noteworthy, it is not to be used independently for clinical decision-making but to be correlated with history and clinical examination findings [28].

With advances in medical care, the number of older people is increasing consequently the prevalence of cardiac abnormalities. Pre-existing literature has noted that rhythm disorders are a known cause of morbidity and mortality in older people [29]. The changes in rhythm have been noted to be due to a host of degenerative and other changes such as a reduction in the pacemaker cell functions and quantity, impaired calcium metabolism and sympathomimetic factors [30].

Earlier studies have also shown that atrial fibrillation and other rate abnormalities are in part explained by myocardial inflammation mediated through non-specific pro-inflammatory cytokines that cause abnormal calcium function leading to predispositions of old people to arrhythmias [31]. Thus, the various rate abnormalities seen in the old patients studied are in consistence with earlier published works.

First-degree Atrioventricular blocks are usually asymptomatic and can be diagnosed on electrocardiography, other conduction abnormalities such as bradycardia and third-degree A-V block reported could also be as a result of degenerative changes in the cardiac conducting system. Although the Atrioventricular block was present in six patients in this study it may be a benign condition as suggested by Sutton et al. [32] and results from increased fibrosis of the conduction system of the heart and modifications in the cardiac muscle.

This study emphasizes the fact that cardiovascular disease is especially common in the elderly population. Electrocardiographic and echocardiographic abnormalities which directly increase the risk of cardiovascular mortality cannot only be elicited by routine history taking and clinical examinations. There is an need for cardiac-specific investigations such as baseline ECG and echocardiography in a bid to achieve early diagnosis, commence effective therapies and prolong life towards achieving the goal of an overall improvement in the quality of life of older people attending geriatric clinics in tropical countries such as Nigeria.

5. CONCLUSION

Electrocardiographic abnormalities in addition to ultrasound cardiac structural and functional changes are prevalent in geriatric patients residing in tropical countries suggesting the need for routine baseline echocardiographic and electrocardiographic assessments of these patients on routine clinic visits.

CONSENT AND ETHICAL APPROVAL

Ethical clearance was obtained from the Research and Ethics Committee of the University of Port Harcourt Teaching Hospital while individual informed consent was obtained from each patient. An interviewer-administered preformed was used to obtain the biodata from the patients.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Naja S, Din Makhlouf MM El, Chehab MAH. An ageing world of the 21st century: A literature review. Int J Community Med Public Heal. 2017;4(12):4363.
2. Nations U, of Economic D, Affairs S, Division P. World Population Ageing. Highlights; 2019.
3. Lakatta EG. Central intelligence and the epidemic of systolic hypertension and atherosclerosis. Journal of the American Society of Hypertension. 2017;1:302-40.
4. Steppan J, Barodka V, Berkowitz DE, Nyhan D. Access to. Res Cardiol Res Pract. 2011;2011.
5. Safar ME, Levy BI, Struijker-Boudier H. Current perspectives on arterial stiffness and Pulse pressure in hypertension and cardiovascular diseases. Circulation. 2003; 107:2864- 9.
6. World Health Organisation. Double strategy on diet physical activity and health.

Bulletin of the world Health Organisation Suppl. 2006;5:16-8.

7. Shiroma EJ, Lee IM. Physical activity and cardiovascular health: Lessons learnt from epidemiological studies across age, gender and racial/ ethnicity. Circulation. 2010;122:743-52.
8. Iloh GUP, Amadi AN, Chuku A, Ikwudinma AO, Nnorom OU. Predictors of abdominal obesity among adult Nigerians in a resource for environment of a rural hospital in Eastern Nigeria. British Journal of Medical Research. 2014;4:2369-82.
9. Iloh GUP, Ikwudinma AO. Abdominal obesity in adult Nigerian Africans: Prevalence and co-occurrence with cardiometabolic risk factors in a resource-poor setting of a rural hospitals in Eastern Nigeria. American Journal of Health Research. 2013;1:73-80.
10. Aronow Wilbert S. Lipid-lowering therapy in older persons. Archives of Medical Science: AMS. 2015;11(1):43-56.
    DOI: 10.5114/aoms.2015.48148
11. Iloh G, Amadi AN, Njoku PU, Ofoedu JN, Awa-Madu J. The magnitude of abdominal adiposity and artherogenic dyslipidemia among geriatric Nigerians with arterial hypertension in a rural hospital in South Eastern Nigeria. Nigerian Journal of Clinical Practice. 2012;15:4628-8.
12. Yohei N, Taku I, Hideki I, Kyohei Y, Shun K, Mitsuaki S, et al. Comparison of outcomes after percutaneous coronary intervention in elderly patients, including 10 628 nonagenarians: Insights from a japanese nationwide registry (J□PCI Registry). J Am Heart Assoc. 2019;8(5): e011183.
13. Huynh-Hohnbaum, Anh-Luu T, et al. Self-management of heart disease in older adults. Home Health Care Services Quarterly. 2015;34(3-4):159-72.
    DOI: 10.1080/01621424.2015.1092909
14. Modin, Daniel, et al. Echo and heart failure: when do people need an echo and when do they need natriuretic peptides? Echo Research and Practice. 2018;5(2):R65-R79.
    DOI: 10.1530/ERP-18-0004
15. Writing Group Members. Lloyd-Jones D, Adams RJ, et al. Heart disease and stroke statistics 2010 update: A report from the American heart Association. Circulation. 2010;121(7):e46-e215.
16. Lakatta EG, Levy D. Arterial and cardiac: Major shareholders in cardiovascular disease Enterprises: Part 2: The aging heart in health: Linked to heart disease. Circulation. 2003;107(2):346-354.
17. Lida P, Ba M, Mg A, Roy T, HK G, et al. Effect of physical activity on age-related changes in cardiac function and performance in women. Circ Cardiovasc Imaging. 2015;8(1):e002086.
18. Gerstenblith G, Frederiksen J, Yin F, Fortuin N. Echocardiographic assessment of a normal adult aging population. Circul Circulation; 1997.
19. Olivetti G, Melissari L, Capasso JM, Anversa P. Cardiomyopathy of the aging human heart. Myocyte loss and reactive cellular hypertrophy. Circ Res. 1991;68(6): 1560-1568.
20. Fleg JL, Lakatta EG. Normal aging of the cardiovascular system. Cardiovascular Diseases in the Elderly. 2007;1-46.
21. Bryg RJ, Williams GA, Labovitz AJ. Effects of agents on the left ventricular diastolic filling in normal subjects. American journal of Cardiology. 1987;59(9):971-974.
22. Browsers FP, Hillege HL, Van Gilst WH, Van Veldhuisen DJ. Comparing new-onset heart failure with reduced ejection fraction and new-onset heart failure with preserved ejection fraction: An epidemiologic perspective. Curr Heart Fail. 2012;9:363-368.
23. Lung B, Vahanian A. Epidemiology of valvular heart disease in the adult. Natt Rev Cardiol. 2011;8:162-72.
24. Roberts WC, Virmani R. Aschoff bodies at necropsy in valvular heart disease. Evidence from an analysis of 543 patients over 14 years of age that rheumatic heart disease, at least anatomically is a disease of the mitral valve. Circulations. 1978;57: 803-7.
25. Nkomo VT, Gardin JM, Skelton TN, et al. Burden of valvular heart diseases: A population-based study. The Lancet. 2006; 368:1005-1011.
26. Nishimura RA, Tajik AJ. Quantitative hemodynamics by Doppler echocardio-graphy: A non-invasive alternative to cardiac catheterization. Prog Cardiovasc Dis. 1994;36:309-342.
27. Oyedeji AT, Akintunde AA, Owojori OO, Peter JO. Spectrum of echocardiographic abnormalities among 168 consecutive referrals to an urban Private Hospital in

south-western Nigeria. Clin Med insights Cardiol. 2014;8(8):35–8.
28. Bhata N, Brass SS, Skolmck AH, Wenger NK. Aortic valve disease in the older adult. J Geriatr Cardiol. 2016;13(12):941-944.
29. Strauss SM, Bluemink GS, Dielenian JP, et al. The incidence of sudden cardiac death in the general population. J Clin Epidemiol. 2004;57:98-102.
30. Fleg JL, Strait J. Age-associated changes in cardiovascular structure and function: A fertile milieu for future disease. Heart Fail Rev. 2012;17:545-554.
31. Goldstein DR, Jalife J. Synergistic research between the centre of original research and the Michigan biology of cardiovascular agents at the University of Michigan. Circ Res. 2017;121: 1221-3.
32. Sutton R. Mobitz type 1 second degree atrioventricular block: The value of permanent pacing in the older patient. Heart. 2013;99:291-2.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/57192