

# Echocardiographic findings and associated factors in HIV-infected patients at a tertiary hospital in Ethiopia

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## Abstract

Noncommunicable diseases including cardiovascular diseases are becoming an important part of human immunodeficiency virus (HIV) care. Echocardiography is a useful noninvasive tool to assess cardiac disease and different echocardiographic abnormalities have been seen previously. The aim of this study was to investigate the echocardiographic abnormalities in HIV-infected patients and factors associated with the findings.

A cross-sectional study was conducted on 285 patients with HIV infection including collection of clinical and echocardiographic data. Logistic regression was used to examine the association between echocardiographic abnormalities and associated factors with variables with a *P* value of <.05 in the multivariate model considered statistically significant.

Diastolic dysfunction was the most common abnormality seen in 30% of the participants followed by ischemic heart disease (19.3%), left ventricular hypertrophy (10.2%), enlarged left atrium (8.1%), pulmonary hypertension (3.6%), and pericardial effusion (2.1%). Diastolic dysfunction was independently associated with increasing age, elevated blood pressure, and left ventricular hypertrophy while ischemic heart disease was associated with male gender, increasing age, and abnormal fasting blood glucose. Left ventricular hypertrophy was associated with increasing age and blood pressure and the later was associated with left atrial enlargement. The level of immunosuppression did not affect echocardiography findings.

A high prevalence of echocardiographic abnormalities was found. Male gender, age >50 years, elevated blood pressure, and elevated fasting blood glucose were associated with echocardiographic abnormalities. Appropriate follow-up and treatment of echocardiographic abnormalities is needed.

**Abbreviations:** AOR = adjusted odds ratio, ART = antiretroviral treatment, CD4 = cluster of differentiation 4, CI = confidence interval, DD = diastolic dysfunction, FBG = fasting blood glucose, HIV = human immunodeficiency virus, LA = left atrium, LAE = left atrial enlargement, LVH = left ventricular hypertrophy, SD = standard deviation, SPHMMC = St. Paul's Hospital Millennium Medical College.

**Keywords:** cardiovascular diseases, echocardiography, human immunodeficiency virus

## 1. Introduction

Human immunodeficiency virus (HIV) infection, with the widespread use of antiretroviral treatment (ART), is showing an evolving trend from a predominantly infectious ailment to a systemic disease that leads to increased manifestations of non-communicable diseases.<sup>[1]</sup> With increased longevity, patients are faced with increasing morbidity and mortality from cardiovascular diseases.<sup>[2,3]</sup> HIV-infected patients have increased risk of developing cardiac dysfunction and a large share of the suffering is considered to be related to HIV infection itself.<sup>[4]</sup>

During earlier periods of the infection, the most common cardiovascular manifestations of HIV were pericardial effusion and cardiomyopathy.<sup>[5]</sup> Pericardial effusion was attributed to opportunistic infections and malignancies that develop in advanced immunosuppression. This pattern has persisted to be seen in developing countries, but in affluent societies, with widespread use of ART, it is shifting gradually to diastolic dysfunction (DD), coronary artery disease, and pulmonary hypertension.<sup>[5]</sup> Echocardiography is a useful noninvasive diagnostic imaging modality that is valuable in the diagnosis of these cardiac manifestations.<sup>[6]</sup>

The study was funded by St. Paul's Hospital Millennium Medical College.

The authors have no conflicts of interest to disclose.

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request. The datasets used in this study are available from the corresponding author on reasonable request.

The funding body had no role in the design, conduct or final decision to submit for publication.

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How to cite this article: Woldeyes E, Fisseha H, Mulatu HA, Ephrem A, Benti H, Alem MW, Ahmed AI. Echocardiographic findings and associated factors in HIV-infected patients at a tertiary hospital in Ethiopia. *Medicine*. 2022;101:33(e30081).

Received: 28 February 2022 / Received in final form: 19 June 2022 / Accepted: 28 June 2022

<http://dx.doi.org/10.1097/MD.000000000030081>

Different mechanisms have been proposed for development of cardiac disease in HIV. Direct infection of myocardium by the virus, opportunistic infections, chronic inflammation, lipodystrophy, and cardiac autoimmunity are included among others.<sup>[4,7,8]</sup> Certain ART medications, use of substances such as alcohol, and nutritional deficiency also contribute.<sup>[7,8]</sup>

Knowing the adverse effects of the infection on the heart early by readily available and noninvasive diagnostic test can help patients prevent morbidity and can be accomplished by the use of echocardiography for screening and monitoring in this group of population.<sup>[9]</sup>

Much of the evidence regarding this subject is mostly derived from studies outside of Africa. In addition, data regarding the echocardiographic abnormalities in HIV-infected patients in Ethiopia are very scanty and have mostly focused on specific diagnosis and not on comprehensive echocardiographic assessment. The objective of this study was to determine the echocardiographic findings in HIV-infected patients and factors associated with the findings.

## 2. Methods

### 2.1. Study design and participants

A cross-sectional study was conducted on patients with HIV infection on ART at St. Paul's Hospital Millennium Medical College (SPHMMC) HIV treatment clinic in Addis Ababa, Ethiopia. Adult HIV clinic at SPHMMC has a total of 4685 patients on active follow-up, with average monthly patient of 1700 and serves up to 70 patients per day. All patients were on ART unless deferred for clinical reasons. There are 2552 patients who were expected to visit the clinic over the data collection period of 6 weeks from January 6, 2020 to February 15, 2020. Assuming a 26% prevalence of echocardiographic abnormalities in HIV-infected patients,<sup>[10]</sup> 5% margin of error, 95% confidence interval (CI), and adjusting for the finite size of the population using population correction formula, the calculated sample size was 265 patients and 285 patients were finally included in the study. Selection of participants was made using systematic random sampling from routine ART clinic visit, with every ninth patient coming in the morning for follow-up invited to participate in the study and the subsequent patient included if the ninth patient did not give consent to participate. All patients >18 years of age who gave written consent to participate were included and pregnant patients were excluded from the study.

### 2.2. Data collection

A questionnaire survey was conducted regarding participants' sociodemographic characteristics and cardiovascular risk factors. Data regarding HIV infection were retrieved from follow-up charts. Cluster of differentiation 4 (CD4) count and viral load done in the previous 6 months were recovered from patient follow-up charts. Subsequently, blood pressure measurement as well as weight and height measurement was done. Diagnosis of hypertension was made in accordance with the International Society of Hypertension Global Hypertension Practice 2020 Guidelines and hypertension was diagnosed if systolic blood pressure was 140 mm Hg and/or diastolic blood pressure was >90 mm Hg.<sup>[11]</sup> Body mass index was classified according to World Health Organization classification.<sup>[12]</sup> Biochemical analysis was done to determine participants' fasting blood glucose (FBG) and serum cholesterol levels. Diagnosis of dyslipidemia was made in the presence of any abnormal serum cholesterol level including total cholesterol >200 mg/dL, triglyceride >150 mg/dL, low-density lipoprotein cholesterol >130 mg/dL, and high-density lipoprotein cholesterol <40 mg/dL or <50 mg/dL for men and women, respectively. Fasting blood glucose was considered elevated if it was  $\geq 100$  mg/dL.

Finally, 2-dimensional transthoracic echocardiography, including M mode, color Doppler, pulse wave, and continuous wave Doppler, was done by experienced cardiologists using a GE VIVID E9 echocardiography machine with 1–5 MHz transducers (GE Vingmed, Horten, Norway). Participants were placed in the left lateral supine position and examined in standard parasternal and apical views. Echo and Doppler study measurements and interpretation were made in accordance with the recommendations of the American Society of Echocardiography guidelines<sup>[13–16]</sup> and pulmonary hypertension was defined according to elevation of tricuspid regurgitant velocity measurement.<sup>[17]</sup> If any abnormality was detected, patients were linked to a cardiologist for follow-up.

### 2.3. Data analysis

Data were summarized using percentages, mean, and standard deviation (SD) and presented in tables and text. Independent Student *t*-test was used to compare continuous variables. Chi-square test and Fisher's exact test, when assumptions of chi-square test were not met, were used to compare categorical variables. Logistic regression was used to examine the association between echocardiographic abnormalities and associated factors. Variables with *P* value <.2 in the univariate analysis were included in the multivariate logistic regression model. All variables with *P* < .05 in the multivariate model were considered statistically significant. Associations between variables were presented in odds ratios with 95% CI.

### 2.4. Ethical approval

This study was approved by the Institutional Review Board of SPHMMC. Written informed consent was obtained from all participants. Each participant's information was collected using an anonymous questionnaire.

## 3. Results

### 3.1. Sociodemographic characteristics

A total of 285 HIV-infected patients on ART participated in the study, out of which 90 (31.6%) were male and 195 (68.4%) were female. The mean age (SD) of study participants was 44.7 years (10.3), with the youngest participant being 19 and the oldest 83 years old.

The mean CD4 count (SD) was 566.9 cells/mm<sup>3</sup> (269) and ranged from 55 to 1477 cells/mm<sup>3</sup>. Viral load was available in 74% of the participants and the mean result was 5634 copies/mL (undetectable – 272,719 copies/mL), with 73.5% having undetectable viral load. The mean number of years since HIV diagnosis was 10.6 (3.9) years. The mean duration of ART was 10.1 (3.9) years. Around 69.8% were taking tenofovir disoproxil fumarate and lamivudine with efavirenz or nevirapine.

Only 5 (1.8%) were active smokers and 7 (2.5%) consumed alcohol in the past 1 month.

FBG was normal in 63.2% of the participants. Out of the total participants, 21.4% had hypertension based on the mean blood pressure measurement. Dyslipidemia was seen in 66% and 10.5% were obese (Table 1).

### 3.2. Echocardiography parameters

All but 1 patient had normal ejection fraction with median ejection fraction of 66% (interquartile range 62%–70%). Most participants (69.1%) had normal diastolic function with 13% having DD only, with the rest having other additional echocardiographic finding in addition to DD. Most of the participants had normal chamber dimensions. The left atrium (LA) was enlarged in 23 (8.1%) of the participants,

**Table 1**  
**Sociodemographic and clinical characteristics of participants, SPHMMC, Addis Ababa, 2020.**

	Total (285)	Male 90 (31.6%)	Female 195 (68.4%)
Age group, yr			
≤39	85 (29.8%)	13 (14.4%)	72 (36.9%)
40–59	163 (57.2%)	67 (74.4%)	96 (49.2%)
≥60	26 (9.1%)	9 (10%)	17 (8.7%)
Missing	11 (3.9%)	1 (1.1%)	10 (5.1%)
CD4 count			
<200	17 (6%)	6 (6.7%)	11 (5.6%)
200–349	35 (12.3%)	8 (8.9%)	27 (13.8%)
350–499	50 (17.5%)	18 (20%)	32 (16.4%)
≥500	135 (47.4%)	42 (46.7%)	93 (47.7%)
Missing	48 (16.8)	16 (17.8%)	32 (16.4%)
Viral load			
<50	166 (58.2%)	54 (60%)	112 (57.4%)
≥50	44 (15.4%)	11 (12.2%)	33 (16.9%)
Missing	75 (26.3%)	25 (27.8%)	50 (25.6%)
Current regimen			
TDF/3TC/EFV OR NVP	199 (69.8%)	61 (67.8%)	138 (70.8%)
AZT/3TC/EFV OR NVP	56 (19.6%)	17 (18.9%)	39 (20%)
TDF/3TC/LPV/R	4 (1.4%)	3 (3.3%)	1 (0.5%)
Other	22 (7.7%)	7 (7.8%)	15 (7.7%)
Missing	4 (1.4%)	2 (2.2%)	2 (1%)
Blood pressure, mm Hg			
SBP < 130 and DBP < 85	183 (64.2%)	46 (51.1%)	137 (70.3%)
SBP 130–139 and/or DBP 85–89	36 (12.6%)	13 (14.4%)	23 (11.8%)
SBP 140–159 and/or DBP 90–99	41 (14.4%)	21 (23.3%)	20 (10.3%)
SBP ≥ 160 and/or DBP ≥ 100	20 (7%)	8 (8.9%)	12 (6.2%)
Missing	5 (1.8%)	2 (%)	3 (%)
Current tobacco smoker	5 (1.8%)	3 (3.4%)	2 (1%)
Alcohol drink in the last 1 mo	7 (2.5%)	3 (3.4%)	4 (2.1%)
Fasting blood glucose			
<100	180 (63.2%)	54 (60%)	126 (64.6%)
100–125	67 (23.5%)	22 (24.4%)	45 (23.1%)
126 or more	25 (8.8%)	8 (8.9%)	17 (8.7%)
Missing	13 (4.6%)	6 (6.7%)	7 (3.6%)
Dyslipidemia	188 (66%)	63 (70%)	125 (64.1%)
No dyslipidemia	92 (32.3%)	25 (27.8%)	67 (34.4%)
Missing	5 (1.8%)	2 (2.2%)	3 (1.5%)
Obesity	30 (10.5%)	10 (11.1%)	20 (10.6%)
No obesity	248 (87%)	77 (85.6%)	171 (87.7%)
Missing	7 (2.5%)	3 (3.3%)	4 (2.1%)
Mean years since diagnosis	10.6 ± 3.9	11.2 ± 4.1	10.3 ± 3.9
Mean years on ART	10.07 ± 3.9	10.9 ± 3.9	9.7 ± 3.9

3TC = lamivudine, ART = antiretroviral treatment, CD4 = cluster of differentiation 4, DBP = diastolic blood pressure, EFV = efavirenz, LPV = lopinavir/ritonavir, NVP = nevirapine, SBP = systolic blood pressure, SPHMMC = St. Paul's Hospital Millennium Medical College, TDF = tenofovir disoproxil fumarate.

while right ventricle, left ventricle, and right atrium were enlarged in 1.1%, 0.4%, and 0.4% of participants, respectively. Ten patients (3.6%) had elevated systolic pulmonary artery pressure. Among the participants, 8.4% had mild left ventricular hypertrophy and 1.8% had moderate to severe hypertrophy (Table 2).

One patient had thrombus in the left ventricle and 8 patients had congenital heart disease. Among the valve lesions, 2 participants had moderate or severe mitral regurgitation and 1 had moderate or severe aortic regurgitation. Three participants had moderate or severe aortic stenosis and 1 patient had moderate or severe mitral stenosis. Six patients had pericardial effusion, which was mostly small or moderate and none of the patients had cardiac tamponade that needed drainage. Two participants had vegetation, 1 on the mitral, and the other on the aortic valve. No patient had atrial thrombus.

Most of the participants (62.1%) had a final conclusion of a normal echocardiography study. The most common abnormal finding was regional wall motion abnormality suggestive of ischemic heart disease seen in 19.3% of the participants followed by DD only in 13%, congenital heart disease in 2.8%,

and rheumatic valvular heart disease in 1.1%. Females were more likely to have a normal echocardiography study (69.2%) compared to males (46.7%;  $P < .001$ ; (Table 3).

### 3.3. Predictors of echocardiography parameters

In multivariate analysis, participants with elevated blood pressure were 4 times as likely to have left ventricular hypertrophy (LVH) on echocardiography (95% CI, 1.82–10.63) and participants >50 years of age had 3 times increased risk of having LVH (95% CI, 1.21–7.1). Hypertension also increased the odds of having an enlarged LA by 4.1 times (95% CI, 1.3–13.15) and the odds of having DD by 2.3 times (95% CI, 1.09–5.03). LVH (adjusted odds ratio, AOR, 12.21; 95% CI, 3.24–46.02) and age >50 (AOR, 3.9; 95% CI, 1.92–8.1) were other factors independently associated with DD. Ischemic heart disease was more likely to be seen in males (AOR, 2.54; 95% CI, 1.2–5.37), in participants >50 years of age (AOR, 3.55; 95% CI, 1.63–7.73) and participants with FBG >100 mg/dL (AOR, 2.3; 95% CI, 1.1–4.8). The severity of HIV infection did not contribute significantly to echocardiography findings (Table 4).

**Table 2**

**Echocardiography parameters of patients, SPHMMC, Addis Ababa, 2020.**

Echocardiography parameter	Total (285)	Male 90 (31.6%)	Female 195 (68.4%)
Mean ejection fraction	66 ± 5.6	65 ± 5	66.4 ± 5.8
Reduced ejection fraction	1 (0.4%)	0	1 (0.5%)
Mean left ventricle end-diastolic diameter	42.1 ± 5.1	43.8 ± 5.1	41.3 ± 4.9
Enlarged left ventricle end-diastolic diameter	1 (0.4%)	0	1 (0.5%)
Mean left atrium end-diastolic diameter	33.1 ± 4.6	34.8 ± 4.9	32.3 ± 4.2
Enlarged left atrium end-diastolic diameter	23 (8.1%)	11 (12.2%)	12 (6.2%)
Mean right ventricle end-diastolic diameter	31.7 ± 4.5	33 ± 5.3	31.1 ± 3.8
Enlarged right ventricle end-diastolic diameter	3 (1.1%)	2 (2.2%)	1 (0.5%)
Mean right atrium end-diastolic minor axis dimension	33.6 ± 4.4	35.4 ± 4.6	32.9 ± 4.1
Enlarged right atrium end-diastolic minor axis dimension	1 (0.4%)	1 (1.1%)	0
Left ventricle diastolic dysfunction			
None	197 (69.1%)	48 (53.3%)	149 (76.4%)
Grade 1	75 (26.3%)	38 (42.2%)	37 (19%)
Grade 2	10 (3.5%)	3 (3.3%)	7 (3.6%)
Missing	3 (1.1%)	1 (1.1%)	2 (1%)
Systolic pulmonary artery pressure			
Normal	273 (96.5%)	86 (95.6%)	187 (95.9%)
Mild elevation	5 (1.8%)	1 (1.1%)	4 (2.1%)
Moderate elevation	1 (0.4%)	0	1 (0.5%)
Severe elevation	4 (1.4%)	1 (1.1%)	3 (1.5%)
Missing	2 (0.7%)	2 (2.2%)	0
Pericardial effusion	6 (2.1%)	1 (1.1%)	5 (2.6%)
Left ventricular hypertrophy			
None	252 (88.4%)	73 (81.1%)	179 (91.8%)
Mild	24 (8.4%)	12 (13.3%)	12 (6.2%)
Moderate	2 (0.7%)	2 (2.2%)	0
Severe	3 (1.1%)	0	3 (1.5%)
Missing	4 (1.4%)	3 (3.3%)	1 (0.5%)

SPHMMC = St. Paul's Hospital Millennium Medical College.

**Table 3**

**Echocardiography conclusion of patients, SPHMMC, Addis Ababa, 2020.**

Conclusion of echocardiography	Total (285)	Male 90 (31.6%)	Female 195 (68.4%)	P value
Normal	177 (62.1%)	42 (46.7%)	135 (69.2%)	<.001
Ischemic heart disease	55 (19.3%)	28 (31.1%)	27 (13.9%)	.001
Rheumatic valvular	3 (1.1%)	2 (2.2%)	1 (0.5%)	–
Non-rheumatic valvular	2 (0.7%)	0	2 (1%)	–
Cardiomyopathy	2 (0.7%)	1 (1.1%)	1 (0.5%)	–
Hypertensive heart disease	1 (0.4%)	0	1 (0.5%)	–
Congenital	8 (2.8%)	5 (5.6%)	3 (1.5%)	.114
Diastolic dysfunction only	37 (13%)	12 (13.3%)	25 (12.8%)	.890

SPHMMC = St. Paul's Hospital Millennium Medical College.

#### 4. Discussion

There was a high prevalence of echocardiographic abnormalities found in this study of HIV-infected individuals. The prevailing abnormalities identified were DD, regional wall motion abnormality, LVH, and left atrial dilation.

DD precedes systolic dysfunction and is considered an early finding of myocardial disease that needs follow-up.<sup>[18]</sup> DD, predominantly grade I (impaired relaxation) was reported in 30% of the participants with normal systolic function. Similar to our finding, DD has been reported to be the most common finding previously.<sup>[7,9,18,19]</sup> It has been reported in as low as 2% up to 85.7% of patients.<sup>[3,7,9,18–21]</sup> A recent systematic review reported pooled prevalence of 29.3%, a number similar to our study.<sup>[4]</sup> Similar to this study, increasing age has been shown to be an independent risk factor for DD in HIV patients<sup>[9]</sup> and is also a known risk factor in the general population.<sup>[22]</sup> Hypertension and LVH are other risks for DD seen in previous studies also supported by our findings.<sup>[3,5,9,22,23]</sup> HIV infection is also a risk factor for DD by itself.<sup>[3]</sup> The level of immunosuppression and viral load did not affect finding of DD in this or some other studies.<sup>[3,7]</sup>

LVH is an important precursor to the development of hypertensive heart disease and is associated with cardiovascular mortality and therefore needs close follow-up and treatment.<sup>[19,24]</sup> LVH was seen in 10.2% of our study participants. Previous studies have reported prevalence of LVH from 4% to 46.9%.<sup>[2,3,19,23,25,26]</sup> This variation could be explained by the use of different methods for the assessment of LVH including indexing for body surface area and height, which was not done in our study. A study done on patients receiving ART showed hypertension to be a risk for LVH, supporting a similar finding in our study.<sup>[23]</sup> Age and hypertension are known risk factors for LVH in the general population.<sup>[24]</sup> The severity of HIV infection was not shown to be a risk for LVH, which was also the case from previous findings.<sup>[3,23,25,26]</sup> A study that compared HIV-infected patients to controls has shown that the infection itself increases risk of LVH.<sup>[3]</sup>

Regional wall motion abnormality is an earlier stage of global LV dysfunction that mandates appropriate management.<sup>[7]</sup> Diagnosis of ischemic heart disease was made after the echocardiographic finding of pathologic contraction (regional wall motion abnormality) was seen in 19.3%. This is higher

**Table 4**  
**Multivariate logistic regression of factors associated with echocardiography parameters, SPHMMC, Addis Ababa, 2020.**

	Crude OR	95% CI	P value	Adjusted OR	95% CI	P value
<b>Left ventricular hypertrophy</b>						
Male gender	0.43	0.2–0.93	.031	1.47	0.6–3.62	.402
Age > 50 yr	7.82	0.68–90.2	.099	2.93	1.21–7.1	.017*
Elevated blood pressure	5.58	2.5–12.4	<.01	4.4	1.82–10.63	.001*
Obesity	2.53	0.94–6.86	.067	2.517	0.84–7.51	.098
<b>Diastolic dysfunction</b>						
Male gender	0.35	0.21–0.6	<.001	0.57	0.29–1.13	.105
Age > 50 yr	4.55	2.55–8.1	<.001	3.94	1.92–8.1	<.001*
Elevated blood pressure	3.83	2.1–7	<.001	2.34	1.09–5.03	.030*
LVH	28.2	8.2–96.9	<.001	12.21	3.24–46.02	<.001*
Obesity	2.6	1.2–5.6	.015	2.61	1–6.82	.051
Dyslipidemia	2	1.09–3.6	.024	1.66	0.77–3.54	.194
Duration of ART	1.48	1.04–2.1	.028	1.16	0.75–1.78	.505
<b>Enlarged left atrium</b>						
Male gender	0.47	0.2–1.11	.083	1.49	0.46–4.8	.503
Age > 50 yr	3.1	0.86–10.77	.083	0.41	0.11–1.46	.168
Elevated blood pressure	5.72	2.37–13.81	<.001	4.14	1.3–13.15	.016*
Obesity	4.73	1.75–12.78	.002	2.18	0.59–8.1	.242
Viral load	0.19	0.03–1.48	.114	0.22	0.02–1.96	.173
LVH	6.02	2.29–15.83	<.001	2.74	0.68–11.1	.158
Diastolic dysfunction	6.3	2.48–15.95	<.001	3.29	0.94–11.51	.063
<b>Ischemic heart disease</b>						
Male gender	0.35	0.19–0.65	.001	2.54	1.2–5.37	.015*
Age > 50 yr	3	0.58–5.6	.001	3.55	1.63–7.73	.001*
FBG ≥ 100 mg/d	2.24	1.22–4.08	.009	2.3	1.1–4.8	.027*
Dyslipidemia	2.48	1.19–5.19	.016	2.16	0.87–5.45	.095
Elevated blood pressure	1.71	0.88–3.34	.115	1.64	0.68–3.96	.270
Duration of diagnosis	0.45	0.14–1.39	.178	0.49	0.07–3.2	.455

ART = antiretroviral treatment, CI = confidence interval, FBG = fasting blood glucose, LVH = left ventricular hypertrophy, OR = odds ratio, SPHMMC = St. Paul's Hospital Millennium Medical College.  
 \*P value <.05.

than most previous studies, which reported regional wall motion abnormality from 1% to 23.2%.<sup>[7,9,10,21,27]</sup> This large difference could be explained by the exclusion of patients with known ischemic heart disease except in 2 of the studies, which had the higher prevalence of 13.5% and 23.2%, which is close to our finding.<sup>[9,10]</sup> In addition to HIV infection itself, traditional cardiovascular risk factors such as increasing age, male gender, and diabetes are supplementary risk factors.<sup>[28,29]</sup> HIV-infected patients have increased risk for coronary artery disease with increasing reports.<sup>[7,8]</sup> The major proposed mechanism is increased endothelial dysfunction but also includes lipodystrophy and impaired glucose metabolism.<sup>[7,8]</sup> Certain ART medications increase level of dyslipidemia, insulin resistance, and C-reactive protein that increase the risk of coronary artery disease.<sup>[5,8]</sup> They also have increased prevalence of traditional cardiovascular risk factors.<sup>[5]</sup> With increasing longevity and decreasing opportunistic infections, coronary artery disease is expected to become an increasing burden.<sup>[8]</sup>

Left atrial enlargement (LAE) in the general population has been shown to be a risk factor for cardiovascular disease including heart failure, atrial fibrillation, and stroke.<sup>[23,30]</sup> LAE was seen in 8.1% of our participants. Previous studies reported atrial enlargement from 2.4% to 40%.<sup>[12,9,23]</sup> The difference could be explained by the use of different cut-off points; usage of linear measurement of LA anteroposterior size and not LA volume measurement in our study; and lack of adjustment made for body surface area. A study comparing HIV-infected and noninfected controls showed larger LA size in infected individuals.<sup>[3]</sup> Hypertension was the only factor independently associated with LAE in our study. Previous studies also found associations with hypertension and LVH.<sup>[12,23]</sup> Similar to our finding, CD4 and viral load have not been found to be significant previously.<sup>[2,3]</sup>

Patients with pericardial effusion potentially have higher mortality and therefore need management as many of the

causes are potentially treatable.<sup>[31]</sup> Pericardial effusion was seen in only 6 (2.1%) of the participants. There is a trend toward decreasing pericardial effusion in HIV patients particularly in developed countries.<sup>[5]</sup> Studies from Congo and Cameroon showed prevalence of effusion of 20.4% and 46.5%, respectively, showing very high prevalence in Africa.<sup>[31,32]</sup> Others reported prevalence of as low as 4% to 16.6%<sup>[7,8,10,21,27,30,33,34]</sup> and in 1 study only 2 patients had pericardial effusion.<sup>[35]</sup> There is a difference of the participants of the studies with some including patients with profound immunosuppression. Pericardial effusion is seen mainly in patients with lower CD4 counts.<sup>[10,21,27,33]</sup>

Reduced ejection fraction was seen in only 1 patient. A systematic review and meta-analysis published in 2018 showed the pooled prevalence of reduced ejection fraction <50% was 12.3%, which was more reduced in patients with AIDS. It indicated the possible relation with immunodeficiency and opportunistic infections and showed lower prevalence in patients on ART, potentially explaining the preserved ejection fraction in our patients.<sup>[4]</sup> There are some studies where ≤4% of the studied population had low ejection fraction.<sup>[2,3,20]</sup>

The sensitivity of echocardiography for pulmonary hypertension is not satisfactory. Invasive tests may be required in patients with strong clinical suspicion as it is associated with increased mortality.<sup>[17,36]</sup> A systematic review and meta-analysis reported prevalence of pulmonary hypertension in 11.5% of patients while this study revealed prevalence of 3.6%.<sup>[4]</sup> A study done in a similar Ethiopian setting showed prevalence of 14%.<sup>[17]</sup> However, other studies also revealed low prevalence of 2.6% and 3.3%.<sup>[2,7]</sup>

There are certain limitations to this study. The cross-sectional nature of the study hinders from making final conclusions about echocardiographic findings and associated factors. There was also no control group for comparison. Despite these limitations,

our study provides a detailed assessment of echocardiographic findings in a large sample of HIV-infected patients and provides new information for the population in the country that was limited to only few echocardiographic parameters. We recommend that future studies should be done taking our limitations into consideration and using a longitudinal study design that takes the effect of time and long ART use into account.

**5. Conclusions**

In conclusion, a high prevalence of echocardiographic abnormalities was found in this study of HIV-infected individuals including DD, ischemic heart disease, LVH, and LAE. Male gender, age >50 years, elevated blood pressure, and elevated FBG were associated with echocardiographic abnormalities. Appropriate follow-up and care of patients with cardiovascular diseases are needed.

**Acknowledgments**

The authors wish to thank St. Paul’s Hospital Millennium Medical College staff and the patients who participated in this study.

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