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Spectrum of Heart Diseases in Sanaa, Capital of Yemen Republic

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Abstract

Background: The spectrum of heart diseases varies between and within countries, depending on the stage of epidemiological transition and risk factor profiles, understanding this spectrum requires regional and national data for each region and country. **Objective:** To assess the spectrum of heart diseases in Sanaa, the Capital of Yemen republic. **Methods:** This retrospective, descriptive registry reviewed abnormal echocardiographic findings of 6044 patients aged 0 - 100 years, (3264 male patients (54%), and 2780 female patients (46%) from January 2019 to May 2022. **Results:** Hypertensive heart disease (HHD) (n: 1597, 26.42%), valvular heart disease (VHD) (n: 1356, 22.44%), heart failure with reduced ejection fraction (HFrEF) (n: 1189, 19.67%) and Ischemic heart disease (I.H.D) (n: 1027, 16.99%) were the most frequent comorbidities. Congenital heart diseases (CHDs) were detected in 123 (2%) of the patients, with the most common ones including atrial septal defect (ASD) (n: 38, (30.89%)) and ventricular septal defect (VSD) (n: 28, (22.76%)). Rheumatic heart disease (RHD) was observed in 693 (51.10%) patients, senile valvular degenerative lesions (SVDL) in 366 (26.99%), mitral valve prolapse (MVP) were detected in 297 (21.9%). Mitral insufficiency (n: 965, (71.2%)) was detected as the most frequent VHD, followed by aortic insufficiency (n: 259, (19.1%)), and tricuspid insufficiency (n: 62, (4.6%)), mitral valve stenosis (n: 46, (3.4%)) and aortic stenosis (n: 24, (1.8%)) was the least common VHD. **Conclusion:** In the present study, we found that HHD was the most common comorbidity, followed by VHD, HFrEF and IHD. Moreover, the most common VHD was mitral insufficiency and the most common CHD was ASD.

Subject Areas

Cardiology

Keywords

Congenital Heart Disease, Rheumatic Heart Disease, Hypertensive Heart

Disease, Valvular Heart Disease, Sanaa, Yemen

1. Introduction

Cardiovascular diseases are the leading cause of death worldwide [1]. The spectrum of cardiovascular diseases varies between and within countries depending on the stage of epidemiological transition and risk factor profiles [2] [3] necessitating regional or national data for each region or country. Knowledge of the full spectrum of cardiovascular diseases will help implement research programmes, advocacy, and education. Reassessment and implementation of public health policy in countries in epidemiologic transition require evidence-based decision-making [4].

The exponential rise in the use of antibiotics and vaccines, and increase in cardiovascular risk factors like hypertension and diabetes owing to Westernisation and Urbanization are creating a rapid shift in the epidemiological transition from communicable to non-communicable diseases [5].

Our study is designed to determine the spectrum of heart diseases in the major Yemeni hospital and cardiac centers in Sanaa.

2. Methods

2.1. Study Population and Design

This retrospective, descriptive, and observational registry reviewed the echocardiographic findings of patients aged 0 - 100 years who were presented to our cardiac center with or without echocardiographic reports from referring hospitals in Sanaa between January 1, 2019, and May 1, 2022. The study was approved by the local scientific ethics committee, the included individuals were informed about the study and asked for their participation, taking the consent of those who agreed to be included in this study.

Data was collected using structural checklist by trained physicians. The data included basic sociodemographic data information and primary diagnosis for previously established cases. The international classification of diseases and related health problems (ICD-9) was used for classification of the cases. The final diagnosis of each case was used. In situations with more than one heart disease in the same case, the different disease conditions were counted separately.

Overall, 6625 subjects visited our cardiac center were screened. 581 individuals who had incomplete, unreliable data and/or those with completely normal echocardiographic findings were excluded from the analysis, accodrdingly a total of 6044 patients with abnormal echocardiographic findings by age group and gender were enrolled in the study.

2.2. The Echocardiography

The echocardiographic procedures done on the cardiac center were performed

with HP-Sonos 7500 system. Echocardiograms were obtained using M-mode, 2D-mode, color flow, and Doppler modalities from the standard transthoracic windowsé (as well as subcostal and suprasternal window) were necessary, off-axis views were obtained to optimize visualization of intra-cardiac masses, adhering to the ASE guideline [6].

Measurements were made over three consecutive cardiac cycles, taking into consideration the calculated mean values. Moreover, any detected cardiac abnormality was labeled and included in its group, recorded into 6 inch paper with a paper speed of 50 mm per second.

Left ventricular posterior wall thickness, interventricular septal thickness, and left ventricular end diastolic and systolic diameters were all measured at the distal to the tips of mitral valve leaflets and at the peak of R-wave on the electrocardiogram.

Echocardiographic reports collected from referral hospitals performed by well qualified and trained cardiologist in such hospitals with separate cardiology departments.

Normal echocardiography was defined as echocardiographic evaluation in which bi-ventricle (both in size and function) and valves are within normal ranges by gender and age group [7] [8].

2.3. Electrocardiogram

Standard 12-lead electrocardiogram recorded with a paper speed of 25 mm per second and standardization of 1 mv per centimeter by Cardimax; an electrocardiographic machine, model FX-7302, made in Japan by Fukuda Corporation.

Hypertensive heart disease (HHD) was diagnosed in patients with hypertension presenting with symptoms and signs of heart failure, with or without concentric/eccentric left ventricular hypertrophy and left atrial enlargement on two-dimensional echocardiography [9] and Doppler/tissue Doppler evidence of LV diastolic dysfunction in the absence of significant valvular heart disease or regional wall motion abnormality.

Valvular heart disease (VHD) was defined as an obvious function and size abnormality with the calculation of velocity (m/s), gradient (mmHg), and area (cm^2) for stenotic valves and with interpretation of qualitative (valve morphology, colour flow, and holodiastolic flow reversal in descending aorta), semiquantitaive (vena contracta width, pressure half time), and quantitative (regurgitant volume, effective regurgitant orifice area), measurements for valve insufficiency in at least one of the heart valves according to European Society of Cardiology guidelines for the management of valvular heart disease [10].

Rheumatic heart disease (RHD) was diagnosed in accordance with the 2012 World Heart Federation criteria for echocardiographic diagnosis of RHD [11], criteria include pathological (seen in two views, jet length, velocity, pan-systolic/pan-diastolic jet in at least one envelope) and morphological features (thickening, and restricted leaflets motion, prolapse, coaptation defect, excessive leaflet tip motion) for valve regurgitation and a gradient increase of ≥4 mmHg in mi-

tral stenosis).

Heart failure with reduced EF (HFrEF) was diagnosed in the presence of risk factors, abnormal ECG, clinical signs (e.g. elevated jugular venous pressure, hepatojugular reflux, laterally displaced apical impulse), and/or symptoms (e.g. reduced exercise tolerance, paroxysmal nocturnal dyspnea, breathlessness, orthopnoea) of heart failure, along with a reduced EF of <50% assessed by echocardiography. Subjects with an LVEF between 41% and 49% were defined as mildly reduced LV systolic dysfunction [12].

Dilated cardiomyopathy (DCMP), LV or biventricular systolic dysfunction and dilatation are not explained by abnormal filling conditions, regardless of being primary or secondary. Systolic dysfunction is defined by abnormal LVEF <45%, and LV dilatation is defined by LV end-diastolic diameters >2 standered deviations from normal according to normograms corrected by body surface area and age [13].

Hypertrophic cardiomyopathy (HCMP) was defined as unexplained maximal wall thickness > 15 mm in any LV myocardial segment or presence of LV septal/posterior wall thickness ratio > 1.3 in normotensive patients and > 1.5 in hypertensive patients [14] [15].

Diastolic dysfunction, which refers to impaired LV relaxation, with or without an increase in filling pressure, was categorized into 4 grades. Grade one (mild diastolic dysfunction: E/A < 0.8, deceleration time (DT) > 200 ms, average E/é ≤ 8), grade two (moderate diastolic dysfunction or pseudonormal phase: E/A 0.8 - 1.5, DT 160 - 200 ms, average E/é 9 - 12), grade three (severe diastolic dysfunction or reversible restrictive filling phase: E/A ≥ 2, DT < 160 ms, average E/é ≥ 13), and grade four irreversible/fixed restrictive filling phase: as grade three with no benefit from a reduction of preload) [16].

Ischemic heart disease (IHD) was diagnosed in patients with angina pectoris (current or past), previous myocardial infarction, and/or documented coronary artery disease, or an ECG feature indicating a previous myocardial infarction and/or a regional wall motion abnormality suggestive of myocardial infarction detected in echocardiography.

Ischemic heart disease included three entities:

1) Angina: Patients with chest pain which is short lived, relieved with termination of the provoking factor or rest and had no typical electrocardiographic features of infarction.

2) Acute myocardial infarction was defined by the presence of elevated high sensitivity troponin together with acute onset chest pain, and/or typical ECG changes.

3) Prior myocardial infarction including patients who present with or without heart failure in whom echocardiography detected regional wall motion abnormality in the absence of a history of acute coronary syndrome [17].

4) To increase the specificity of echocardiography, the risk profile of the patients (such as age, presence of coronary risk factors) and/or pathologic Q waves on ECG were used to predict the possibility of ischemia as a cause of the regional

wall motion abnormality in a dilated left ventricle with reduced ejection fraction. This definition and the criteria have also been used in similar resource constrained settings [18]. We acknowledge that regional wall motion abnormality on echocardiography has limitations in reliably differentiating ischemic heart disease from dilated cardiomyopathy, particularly in a dilated left ventricle with reduced ejection fraction. Regional wall motion abnormality in a non-dilated ventricle has a very high specificity for myocardial ischemia (approaching 100%) [19].

Pulmonary arterial hypertension was defined as the presence of systolic pulmonary artery pressure (SPAP) ≥2.8 m/sec or ≥36 mmHg in echocardiography, in addition to symptoms and other findings that are associated with pulmonary hypertension.

Congenital heart disease (CHD) was systematically assessed for using the sequential segmental approach (European approach on account of the promoters of the original concept) [20].

Pericardial effusion was diagnosed in the presence of an echo-free space between the visceral and the parietal pericardium. The classification was as follows: mild (<10 mm), moderate (10 - 20 mm), and severe (>20 mm). Constrictive pericarditis was diagnosed with the help of conventional imaging methods (chest X-ray and computerized tomography-thickened, calcified, fibrotic pericardium) and certain echocardiographic findings (including respirophasic ventricular septal shift-septal bounce, hepatic vein diastolic flow reversal with expiration, preserved/exaggerated medial mitral annulus early diastolic (é) velocity of ≥9 cm/s, at least >25% respiratory variation of peak mitral E-wave velocity, and medial é /lateral é ≥0.91), together with the symptoms and signs of heart failure.

2.4. Statistical Analysis

Data management and analysis were performed with IBM SPSS software version 11.0 (SPSS, Inc. Chicago, Illinosis). Continuous variables were expressed as mean ± SD (standard deviation) and categorial variables expressed as percentages. Differences in categorical variables were assessed by Chi-square analysis.

A 2-tailed P value < 0.05 was considered to be significant.

3. Results

Of 6625 patients initially enrolled in the study, 6044 (3261 (53.95%) male patients, 2783 (46.05%) female patients) were included for final analysis. The remaining 583 patients were excluded due to normal reports or lack of proper and reliable echocadiographic reports.

Demographic characteristics of the study population are as shown in **Table 1** and **Figure 1**. The study population contained more males (3261, 53.95%) than females. The mean age of the patients was 48.96 ± 18.29 years with age range of 1 - 100 years. The median age of the patients is 50 years. Females were younger than males (mean 46.13 ± 17.59) years VS 51.76 ± 18.54 years. Higher proportion of

Table 1. Demographic characteristics of the study population.

Characteristics	Sex		Total
	Male: n (%)	Female: n (%)	
Mean age (SD)	51.76 (18.54)	46.13 (17.59)	48.96 (18.29)
Median age	55	47	50
Age range	1 - 100	1 - 95	1 - 100
Age group (yrs): (%)			
<18 years	163 (2.69)	198 (3.27)	361 (5.96)
19 - 30	273 (4.51)	471 (7.79)	744 (12.30)
31 - 40	406 (6.72)	457 (7.56)	863 (14.28)
41 - 50	486 (8.04)	733 (12.12)	1219 (20.16)
51 - 60	715 (11.82)	562 (9.33)	1277 (21.15)
61 - 70	628 (10.40)	395 (6.54)	1023 (16.94)
≥71 & more	360 (5.96)	197 (3.25)	557 (9.21)
Total	3031 (50.14)	3013 (49.86)	6044 (100)

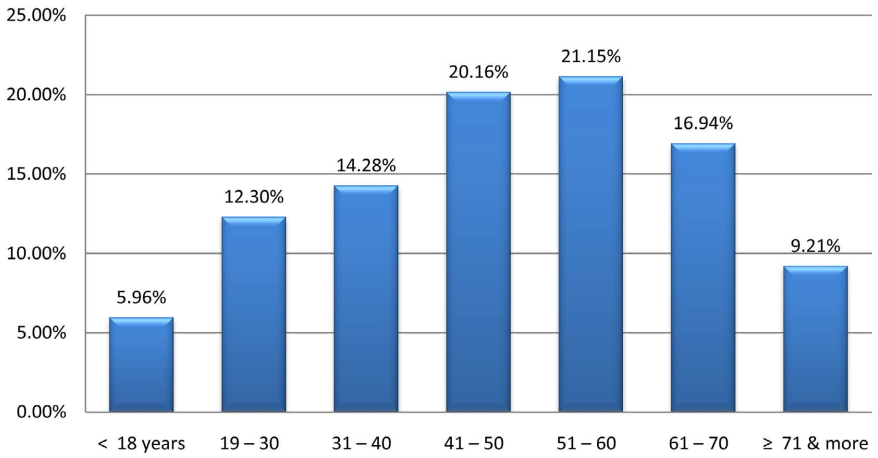

Figure 1. Distribution of patients according to age.

the patients were in the age group 51 - 60 years (21.15%) followed by age group 41 - 50 years (20.16%) while patients age group under 18 years accommodated only for 5.96%.

The distribution of clinical conditions according to primary diagnosis of the study subjects is shown in Figure 2. The six most common diagnoses were hypertensive heart disease (26.42%), valvular heart disease (22.44%), dilated cardiomyopathy (19.7%), ischemic heart disease (16.99%), congenital heart disease (2.0%) and pericardial wall disease (1.5%).

There were 1356 (22.44%) cases of valvular heart disease (VHD) of various etiologies, the most common being rheumatic heart disease (RHD) 693 (51.10%) followed by degenerative valvular heart disease 366 (27.0%) and mitral valve prolapse (MVP) was diagnosed in 297 (21.9%), as shown in Table 2.

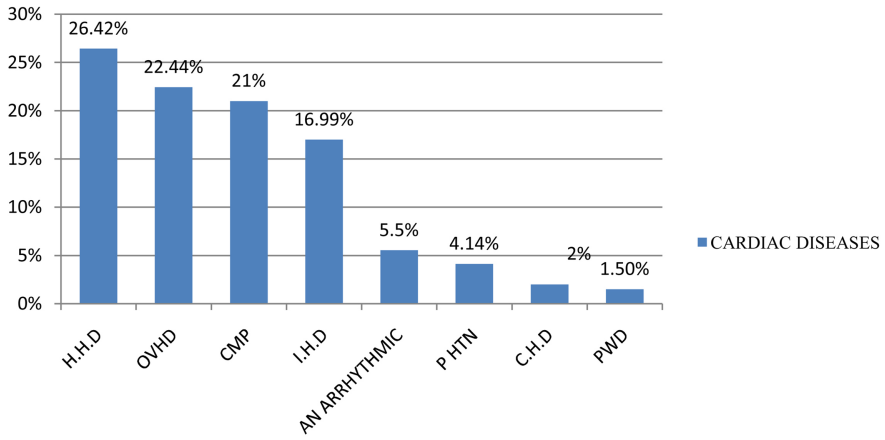

Figure 2. Distribution of cardiac diseases.

Table 2. Distribution of valvular heart disease in study patients.

	Frequency	%	Percent
RHD	693	51%	11.5%
OVHD	366	27%	6%
MVP	297	22%	4.9%
Total	**1356**	**100%**	**22.4%**

The prevalence of cardiomyopathies was 21%, and they were the third commonest type of heart disease in our setting. Dilated cardiomyopathy remained the most common type of cardiomyopathy, accounting for 93.8% of cardiomyopathies (**Figure 3**).

Ischemic heart disease (IHD) was the fourth commonest heart disease in our study, with a prevalence of 16.99%. I.H.D with echo based diagnosis was 75.6% and coronary angiography based diagnosis were 24.4% (**Figure 4**).

In patients <18 years of age valvular heart disease was the most common diagnosis followed by congenital heart disease. Of the congenital heart disease, atrial septal defect (ASD) was the most common, accounting for 38 (31.0%), ventricular septal defect (VSD) was diagnosed in 28 (22.8%), patent ductus arteriosus (PDA) 24 (19.5%), tetralogy of fellot (TOF) 17 (13.8%), common AV canal was diagnosed in 9.0 (7.3%), L-transposition of great arteries (L-TGA) was diagnosed in 4 (3.2%), Ebstein anomaly 2 (1.6%) and coarctation of aorta (COA) was diagnosed in 1 (0.8%), as shown in **Table 3**.

Cor-pulmonale was diagnosed in 2.8% and isolated Pulmonary hypertension accounted 1.3%.

Pericardial wall disease was the least common prevalence of our setting 90 (1.5%).

Arrhythmia with several varities accounted for 332 (5.5)% of our population, atrial fibrillation accounted 44.3%, ventricular ectopy 41.6%, left bundle branch block 9.34%, right bundle branch block 3.6% and wolff Parkinson white syndrome detected in 1.2% of our population, as shown in **Figure 5**.

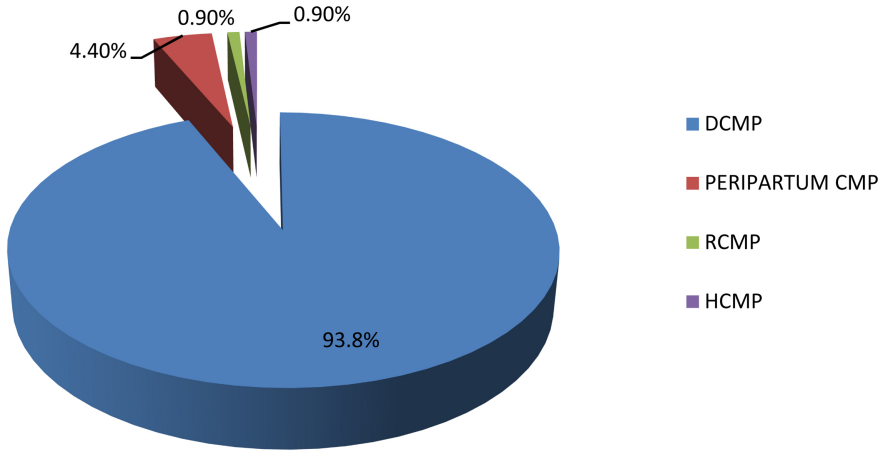

Figure 3. Distribution of cardiomyopathy in study patients.

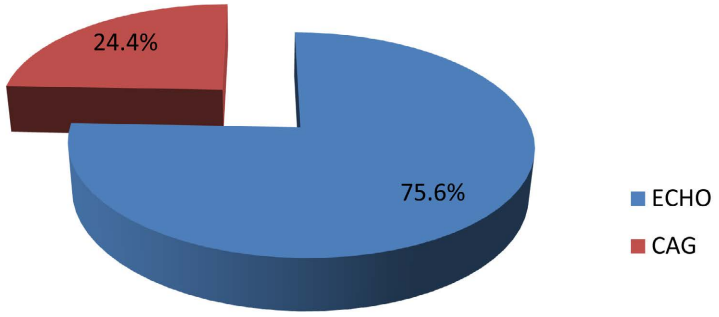

Figure 4. Method of diagnosis of I.H.D.

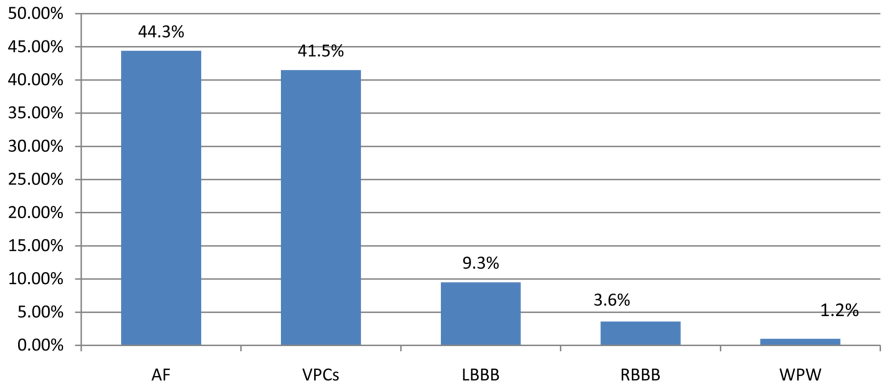

Figure 5. Distribution of arrhythmia in study population.

4. Discussion

To the best of our knowledge, this is the first echocardiographic study on the spectrum of heart disease in Yemen republic.

Hypertensive heart disease was the leading type of heart disease in our setting, accounting for 26.42%, this is similar to findings of Tchoumi and Bureta conducted in a rural setting and other semi-urban and urban settings [21] [22] [23] [24]. Given the high hypertension rate in many population, coupled with the contrastingly poor awareness, treatment and control rates [25], our findings

Table 3. Distribution of congenital heart disease in study patients.

	Frequency	%	Percent
ASD	38	30.9%	0.62%
VSD	28	22.8%	0.5%
PDA	24	19.5%	0.39%
TOF	17	13.8%	0.28%
COMMON AV CANAL	9	7.3%	0.1%
TGA	4	3.2%	0.06%
EBSTEIN ANOMALI	2	1.6%	0.03%
COA	1	0.8%	0.016%
Total	**123**	**100%**	**2%**

were expected. Similar findings have been reported in other Sub-Saharan Afriac (SSA) series [26] [27] [28].

However, our results differ from studies conducted in East Africa. For example, in an Ethiopia study, valvular heart disease was the commonest heart disease [29]. In addition, pericardial wall diseases were the main types of heart disease in a Malawian study [30]. This discrepancy could be due to the relatively younger population in the Ethiopian study (Abdissa SG *et al*.).

Valvular heart disease was the second most common type of heart disease in our setting. It accounted for 22.44% of the study population, and that is similar to other studies [31] [32] and of these 11.5% was secondary to rheumatic heart disease, and 6.0% was secondary to degenerative heart disease and mitral valve prolapse accounted 4.9% of the population. Our findings are contrary to those of Nkoke *et al*. and Jingi *et al*. of the West and Southwest regions of Cameroon respectively, who reported cardiomyopathies as the second leading type of heart disease. In most previous studies involving both inpatient and outpatient follow up clinics, VHD was considered to be the leading cause of CVD in general and cardiac diseases in particular [33] [34]. We found that rheumatic heart disease was the leading condition in the groups of patient less than 30 years of age. VHD in the present study was predominant in females (P = 0.01) and it is in agreement with Habte B *et al*.

Most studies report a predominance of mitral valve involvement in rheumatic heart disease. The present study confirms this observation. Mitral insufficiency (n: 965, (71.2%)) was detected as the most frequent VHD, followed by aortic insufficiency (n: 259, (19.1%)), and organic tricuspid insufficiency (n: 62, (4.6%)), mitral valve stenosis (n: 46, (3.4%)) and aortic stenosis 24, (1.8%) was the least common VHD.

The prevalence of cardiomyopathies was 21%, and they were the third commonest type of heart disease in our setting. Dilated cardiomyopathy remained the most common type of cardiomyopathy, accounting for 93.8% of cardiomyopathies. That is similar to those reported in Alici *et al*., Akono *et al*., A.G.B.

Amoah *et al*. [35], in which cardiomyopathies were the third commonest heart disease, but differ from those reported in other studies in which cardiomyopathies were the second most common type of heart disease Jingi AM *et al*. and Talle M *et al*.

Though dilated cardiomyopathies were still the major types of cardiomyopathies peripartum cardiomyopathies were the second most common cardiomyopathies with a proportion of 4.4%, hypertrophic cardiomyopathy were the third common cardiomyopathies accounting for 1.6% of cardiomyopathies, and restrictive cardiomyopathy 0.32% was the least common cardiomyopathy in our study.

Ischemic heart disease (IHD) was the fourth commonest heart disease in our study, with a prevalence of 16.99% it is about the highest in compare to other studies such as, Latheef *et al*., (12.63)% [36] and Beegom *et al*., (13.9%) [37]. The high prevalence of IHD by our echocardiographic-based study can be explained by spread of khat chewing habit and increased prevalence of risk factors such as tobacoo smoking during khat chewing and also khat induced hypertension and IHD among Yemeni people and that is reported by other studies [38] [39], also it has been reported that the prevalence of hypertension in Yemen is the highest in Asia (30.7%) [40].

Pericardial wall disease accounted 1.5% in our population and that is similar to several studies, Sani *et al*., Ukoh *et al*., and Aje *et al*. [41] [42] [43] and relatively lower than that reported by Lke *et al*. and Tchoumi *et al*. [44]. However, findings in Malawi report pericardial disease as the leading burden of heart disease; associating it to the coinciding HIV epidemic Allain TJ *et al*.

Arrhythmia with several varities accounted for 5.5% of our population, atrial fibrillation accounted 44.30%, ventricular ectopy 41.50%, left bundle branch block 9.30%, right bundle branch block 3.60% and wolff Parkinson white syndrome detected in 1.2% of our population. Atrial fibrillation followed by ventricular ectopy are the commonest arrhythmia in our setting and that are similar to that in Tachoumi *et al*.

Cor-pulmonale was diagnosed in 2.8% and isolated Pulmonary hypertension accounted 1.3% and that is similar to Adesina *et al*. [45].

Congenital heart disease prevalence was 2% and that is similar to what was reported in Agomuoh *et al*. Our finding of ASD (30.69%) being the dominant type of CHD followed by VSD (22.8%) and PDA (19.5%) is similar to what was reported by Alici *et al*.

5. Limitation

Our study is limited by the fact that the data reported are only based on echocardiography. Details on the description and severity of the cardiac diseases are lacking.

Lack of investigations for definitive diagnosis of ischemic heart disease is another limitation of the study.

Due to retrospective nature of the study and envolvement of echocardiographic reports from multiple centers so echocardiography done by different echocardiographers and intra and inter-observer reproducibility analysis, thus, could not be performed.

6. Conclusion

In the present study, we found that HHD was the most common comorbidity, followed by VHD, HFrEF and IHD. Moreover, the most common VHD was mitral insufficiency and the most common CHD was ASD. Therefore, strategies should be directed towards primary and secondary prevention of risk factors against hypertension and other cardiovascular risk factors IHD and acute rheumatic fever.

Conflicts of Interest

The authors declare no conflicts of interest.

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