International Journal of General Medicine

Dovepress

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ORIGINAL RESEARCH

Etiologies and Patterns of Valvular Heart Disease Among Cardiac Patients at the Cardiac Center of Ethiopia During February 2000 to April 2022

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Background: The leading global contributor to cardiovascular morbidity and mortality is valvular heart disease. It is on the rise worldwide, including in the developing countries. However, the prevalence, patterns, and etiologies of valvular heart disease have not been well studied in Ethiopia. Hence, the purpose of this study was to evaluate the prevalence, patterns, and etiologies of valvular heart disease at the Cardiac Center of Ethiopia from February 2000 to April 2022.

Methods: This institution-based retrospective cross-sectional study was conducted between February 2000 and April 2022. Data from three thousand two hundred fifty-seven VHD were extracted from the electronic medical records and analyzed using SPSS version 25. Descriptive statistics, such as the frequency, mean ± standard deviation, and cross tabulations, were used to summarize the data.

Results: Of 10,588 total cardiac cases registered and treated at the Cardiac Centre of Ethiopia from February 2000 to April 2022, 30.8% (3257) were diagnosed with VHD. The most typical diagnosis for VHD was multi-valvular involvement, which accounted for 49.5% of cases (1612), followed by pulmonary stenosis (15%) and mitral regurgitation (14.3%). Females were more likely to develop valve diseases than males, being at the highest risk for each identified etiology of valve disease 1928 (59.2%). The majority percentages of the population affected by VHD were between 18 and 44 age category 1473 (45.2%). The most common etiology of VHD was rheumatic 2015 (61.87%), followed by congenital origin 828 (25.42%).

Conclusion: VHD affects nearly one-third of all cardiac cases admitted to the hospital. Multi-valvular involvement is the most commonly diagnosed form of VHD. Rheumatic causes were more prevalent in this study. As found in this study, VHD affects a significant percentage of the population, which in turn could have an impact on the country's economy and deserve attention as a possible means of intervention.

Keywords: Cardiac Center of Ethiopia, etiology, patterns, valvular heart disease

Introduction

Reports of valvular heart disease (VHD) are increasing worldwide as a result of increasing survival rates and an aging population.[1] One of the four heart valves—the aortic, mitral, tricuspid, or pulmonary valve—either sustains damage or develops a defect as the cause of the condition. These valves may sustain congenital or acquired damage.[2] Valvular stenosis and valvular insufficiency are the two main classes of VHD. Valvular stenosis occurs due to stiffening and reduced elasticity of the valve leaflets, which can lead to narrowing of the valve opening and subsequent reduction in blood flow. Valvular regurgitation occurs because of incomplete closure of valve leaflets, leading to leakage or regurgitant flow development.[3] Mitral stenosis (MS), mitral regurgitation (MR), aortic stenosis (AS), aortic regurgitation (AR), tricuspid stenosis (TS), tricuspid regurgitation (TR), pulmonary stenosis (PS) and pulmonary regurgitation (PR) are all examples of VHD.[4]

Globally, the prevalence of VHD varies greatly, with functional and degenerative diseases predominating in high-income countries and rheumatic heart disease predominating in low- and middle-income nations.[1,5,6] Rheumatic heart disease (RHD), which affects 33.4 million people worldwide, continues to be the most common cause of VHD in developing nations.[7] Valvular heart disease is relatively common in developed nations, with a prevalence of about 2% and increases significantly after the age

Received: 25 May 2023
Accepted: 23 June 2023
Published: 4 July 2023

of 65.[8,9] In China, the weighted prevalence of VHD was 3.8% and found to be increased with age, hypertension, and chronic kidney disease.[10] The most prevalent form of valve disease in Africa is rheumatic heart disease (RHD), which is caused by rheumatic fever, while age-related valve disease is less prevalent than VHD.[11]

When compared to non-rheumatic valvular heart disease (NRVHD), the incidence of RHD fell by 8.67% globally between 1990 and 2017. Additionally, the age-standardized disability-adjusted life year rate of NRVHD decreased by 12.62%.[12] Furthermore, the burden of illnesses caused by degenerative mitral valve disease and calcific aortic valve disease is rising. About 12.6 million cases of calcific aortic valve disease and 18.1 million cases of degenerative mitral valve disease were estimated to have occurred globally in 2017.[12]

According to the EURObservational Research Programme Valvular Heart Disease II Survey, of 7247 patients surveyed, 5219 patients (72%) had severe native VHD. These patients had aortic stenosis in 2152 patients (41% of native VHD), aortic regurgitation in 279 patients (53%), mitral stenosis in 234 patients (45%), mitral regurgitation in 1114 patients (21%; primary in 746 and secondary in 36 8), multiple left-sided VHD in 1297 (24.9%), and right-sided VHD in 143 (2.7%).[13]

Degenerative valve diseases are prevalent in the West; however, in Africa, acute rheumatic fever and chronic rheumatic valvular disease are frequent and impose a huge burden on limited healthcare resources.[14] Up to one-fourth of all cardiovascular in-hospital admissions are due to VHD, which is common and increases with age. VHD is a growing public health issue that must be addressed in terms of its causes, symptoms, and treatments.[15]

Rheumatic heart disease is a major cause of valvular heart disease and the most common cardiovascular disorder in Ethiopian patients at the largest public hospital in Ethiopia. This is often because of inadequate access to antibiotics and medical care for streptococcal infections, which can lead to the development of rheumatic heart disease. Furthermore, other risk factors, such as poverty, malnutrition, and overcrowding, can exacerbate the incidence of VHD.[16]

Contemporary epidemiological information on VHD is important to better understand this changing disease spectrum and allocate healthcare resources accordingly. Heart disease has several causes; however, valvular heart disease is the major cause. It disproportionately affects youth in Ethiopia and is the main contributor to cardiovascular disease.[17] Therefore, this study aimed to assess patterns and etiologies associated with valvular heart disease in patients registered and treated at the Cardiac Centre Ethiopia from February 2000 to April 2022.

Materials and Methods

Study Area and Period

This study was carried out at the Cardiac Center of Ethiopia, Addis Ababa, Ethiopia, between January 01 and February 18, 2023. A cardiac center is a specialty clinic that offers comprehensive cardiac care, including treatment and follow-up, as well as a referral center for cardiovascular care in Ethiopia. It is located in Addis Ababa City, within the Tikur Anbessa Specialized Hospital.

Study Design

A hospital-based retrospective cross-sectional study was employed.

Source and Study Population

The source population for this study was all cardiovascular disease electronic medical records at Cardiac Centre Ethiopia from February 2000 to April 2022, whereas the study population was Echocardiography (ECHO) confirmed VHD electronic medical records of patients admitted and treated at Cardiac Centre Ethiopia.

Sample Size and Sampling Technique

The sample size was not determined for this study, as we retrospectively reviewed all available (3257) patients with a diagnosis of VHD, which was confirmed by echocardiography between February 2000 and April 2022.

Inclusion Criteria and Exclusion Criteria

The study included all patients with valvular heart disease confirmed by echocardiography. All patients aged 1 year and above were also included in the study. Patients without complete or accurate data were not included in the study.

Data Collection Tools

A checklist was designed to collect data on the patients' sex, age, diagnosis, patterns, and etiologies of VHD.

Data Analysis

For data entry and analysis, Epi-data version 4.6 and SPSS version 25.0, respectively, were used. Cross-tabulations and descriptive statistics like frequency and percentage were used to summarize the data.

Results

Patterns and Severity of VHD

Of 10,588 total cardiac cases registered in the Cardiac Centre of Ethiopia between February 2000 and April 2022, 30.8% (3257) were diagnosed with VHD. The mean age of the patients was 28.18 ± 22.81 years.

Multiple VHDs involving two more valves were the most commonly diagnosed valvular heart diseases 49.5% (1612) followed by PS 15% (488), MR 14.3% (466), and MS 10.6% (346), and the least common was AS 2.1% (2.1%) and PR 0.5% (0.5%). The majority of the patients had severe forms of VHD 26.5% (864), followed by mild forms 16.8% (548), and moderate forms 7.1% (230) (Table 1).

Table 1 Patterns of Valvular Heart Disease and Its Severity Among Valvular Heart Disease Patients Registered to the Cardiac Centre of Ethiopia from February 2000 to April 2022 (N = 3257)

S. No	Types of VHD	N (%)	Severity	N (%)
1.	AS	70(2.1)	Mild Moderate Severe	22(0.67) 9(0.27) 39(1.19)
2.	AR	125(3.8)	Mild Moderate Severe	45(1.38) 34(1.04) 46(1.41)
3.	MS	346(10.6)	Mild Moderate Severe	39(1.2) 6(0.18) 301(9.24)
4.	MR	466(14.3)	Mild Moderate Severe	181(5.55) 99(3.03) 186(5.71)
5.	PS	488(15)	Mild Moderate Severe	201(6.17) 47(1.44) 240(7.36)
6.	PR	15(0.5)	Mild Moderate Severe	8(0.24) 6(0.18) 1(0.03)
7. 8.	TR Multiple VHD	135(4.1) 1612(49.5)	Mild Moderate Severe ———	54(1.65) 30(0.92) 51(1.56) 49.5

Abbreviations: AS, Aortic stenosis; AR, Aortic regurgitation; MS, Mitral stenosis; MR, Mitral regurgitation; PS, Pulmonary stenosis; PR, Pulmonary regurgitation; TR, Tricuspid regurgitation; Multiple VHD, Multiple valvular heart disease.

Distribution of VHD Based on Age and Gender

Regarding the distribution of VHD based on sex, a significant proportion of VHD patients were female 1928 (59.2%). Multiple VHDs involving two or more valves were the most commonly diagnosed VHD both in males 649 (19.92%) and females 963 (29.56%), followed by MR in females 298 (9.15%), PS in males 228 (7%). The least prevalent valvular lesions were TR both in males 67 (2.06%) and females 68 (2.08%), PR both in males 7 (0.21%) and females 8 (0.25%) (Table 2).

Regarding the distribution of VHD based on age category, the majority of the population affected by VHD was 18–44 years of age, 1473 (45.2%) followed by 1–17 years of age 1273 (39.08%) and 45–54 years of age 189 (5.8%). Multiple VHDs were the most prevalent type of valvular disease in all age groups. AS 26 (0.79%), MR 209 (6.41%), PS 380 (11.6%), PR 9 (0.27%), and TR 86 (2.64%) had the highest percentages in the 1–17 age group. Similarly, MS 227 (6.96%) and AR 50 (1.53%) were higher among the 18–44 age groups (Table 2).

Etiologies of VHD

The etiology of VHD is shown in Figure 1 and Table 3. The most common etiology of VHD was rheumatic (61.87%), followed by congenital (25.42%), unknown etiology (10.9%), and degenerative valve disease (1.81%) (Figure 1). Rheumatic valve disease etiology was high among the 18–44 age category 1073 (32.94%), congenital disease etiology was high among children or 1–17 age category 538 (16.52%), and degenerative valve disease was high among the old age group (=75) 14 (0.43%) (Table 3).

Regarding the identified etiologies of valve diseases based on sex, the rheumatic cause was 1212 (37.2%), congenital causes were 476 (14.6%), degenerative causes were 30 (0.92%) and unknown etiology was 210 (6.5%). All identified etiologies of valve disease were higher in women than in males. Based on the types of VHD, rheumatic causes were higher in multiple VHDs 1285 (39.4%), MR 276 (8.5%), MS 262 (8%), and AR 57 (1.75%), and congenital causes were higher in PS 376 (11.54%), multiple VHDs 149 (4.6%), MR 126 (3.9%) and TR 75 (2.3%). A small percentage of degenerative causes was identified in multiple VHDs 26 (0.34%) followed by MR 10 (0.3%) (Table 3).

Discussion

This study retrospectively analyzed 22 years of data (from February 2000 to April 2022) of the electronic medical records of patients with echocardiography-confirmed VHD at the Cardiac Center of Ethiopia. Of 10,588 total cardiac cases, the prevalence rate of VHD was 30.8%. This is comparable to a prevalence study of rheumatic heart disease in rural Ethiopia, which reported a prevalence of 37.5 per 1000 population.[18] Valvular heart disease was the most prevalent diagnosis, accounting for 40% (2541) of cases, according to similar studies carried out at six major referral centers in

Table 2 Types of VHD Based on Age and Sex Distribution Among Valvular Heart Disease Patients Registered to the Cardiac Centre of Ethiopia from February 2000 to April 2022 (N = 3257)

Types of VHD		Age Category						Sex Category	
		1–17 N (%)	18–44 N (%)	45–54 N (%)	55–64 N (%)	65–74 N (%)	≥75 N (%)	Male N (%)	Female N (%)
1	AS (N=70)	26(0.79)	19(0.58)	4(0.122)	4(0.122)	8(0.25)	9(0.27)	34(1.04)	36(1.1)
2	AR (N=125)	45(1.38)	50(1.53)	9(0.27)	7(0.21)	5(0.153)	9(0.27)	70(2.15)	55(1.69)
3	MS (N=346)	58(1.78)	227(6.96)	34(1.04)	17(0.52)	7(0.21)	3(0.09)	106(3.25)	240(7.4)
4	MR (N=466)	209(6.41)	168(5.15)	23(0.7)	25(0.78)	22(0.675)	19(0.58)	168(5.16)	298(9.15)
5	PS (N=488)	380(11.6)	93(2.85)	1(0.03)	3(0.092)	4(0.122)	7(0.21)	228(7)	260(8)
6	PR (N=15)	9(0.27)	6(0.18)	0(0)	0(0)	0(0)	0(0)	7(0.21)	8(0.25)
7	TR (N=135)	86(2.64)	29(0.89)	6(0.18)	5(0.153)	6(0.18)	3(0.092)	67(2.06)	68(2.08)
8	Multiple VHD (N=1612)	460(14.12)	881(27.04)	112(3.43)	57(1.75)	60(1.84)	42(1.23)	649(19.92)	963(29.56)
Total		1273(39.08)	1473(45.2)	189(5.8)	118(3.62)	112(3.43)	92(2.82)	1329(40.8)	1928(59.2)

Abbreviations: AS, Aortic stenosis; AR, Aortic regurgitation; MS, Mitral stenosis; MR, Mitral regurgitation; PS, Pulmonary stenosis; PR, Pulmonary regurgitation; TR, Tricuspid regurgitation; Multiple VHD, Multiple valvular heart disease.

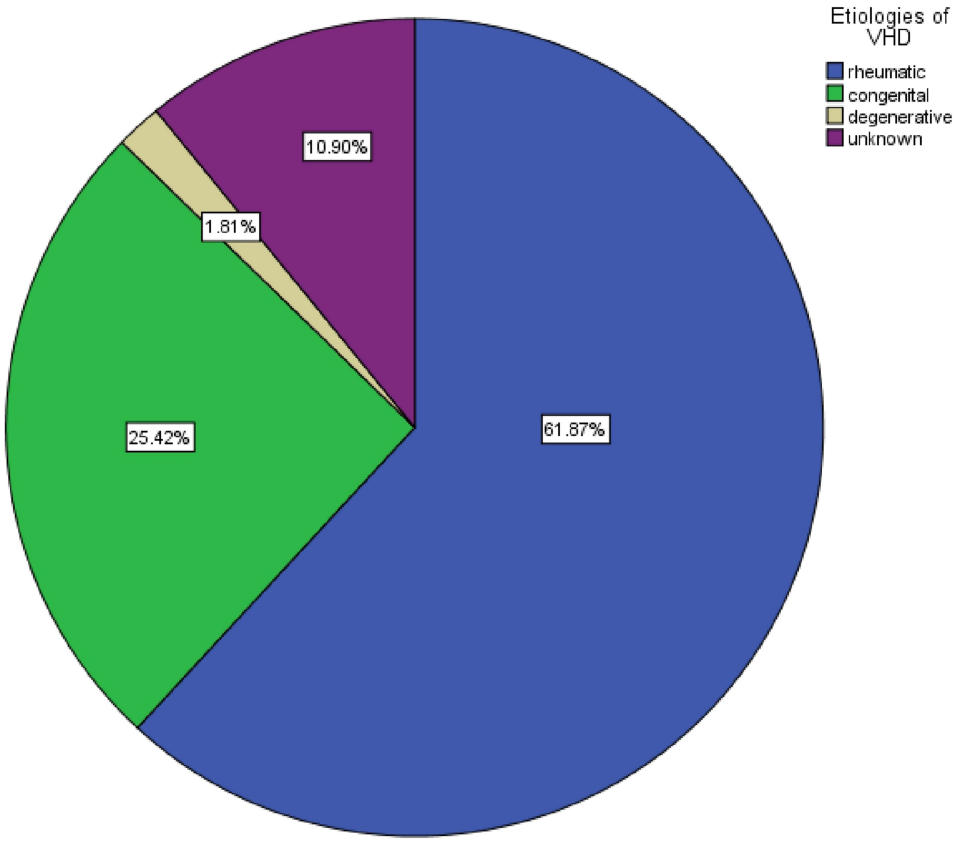

Figure 1 Etiologies of VHD among valvular heart disease patients registered to the Cardiac Centre of Ethiopia from February 2000 to April 2022 (N = 3257).

Ethiopia, which is a slightly higher prevalence than the current study.[19] An echocardiographic study done in referral hospitals of Mogadishu also reported that the prevalence of VHD was 34.6% which is in line with the current findings.[20] Another community-based cross-sectional study conducted in Dar es Salaam, Tanzania, reported the prevalence of rheumatic heart disease was 34 per 1000 among school children.[21]

According to the current study, VHD patterns of VHD were identified and multiple VHDs involving two or more valves were the most commonly diagnosed VHD which was 49.5%. This study is similar to the cross-sectional study at the cardiac unit of St. Paul's Hospital Millennium Medical College, Addis Ababa, Ethiopia, where multiple valves accounted for more than half of all cases of VHD (57.0%).[22] This study finding is also comparable with that study conducted in Bangalore, South India, where multiple valves were affected in more than a third of all cases of VHD.[23] According to a cross-sectional study conducted in China, even though MR was the most prevalent VHD (79.1%, 95% CI 78.2% to 79.9%), patients who had VHD as their primary diagnosis were more likely to have multiple VHD (41.1% vs 19.1%, p 0.0001).[24]

However, in a nationwide cohort study of 4089 patients from a Korean valve survey of 45 medical centers, there were 33.8% cases of MR.[25] In the Swedish population (n = 10,164,211), AS contributed 47.2% of the VHD diagnoses.[26] Another prospective cross-sectional study conducted at Jimma Medical Center, a tertiary hospital in Jimma City, Southwest Ethiopia, also reported that MR (87.2%) was the most common valvular lesion.[27] A similar study done by Desta et al also reported that 136 (97.1%) of patients had mitral regurgitation, which was significantly higher than our study findings.[28] This variation could be due to differences in study design and sample size.

Concerning the severity of the disease, this study found that the majority (26.5%) of the patients had a severe form of VHD, which was supported by various studies.[22,29,30] However, this finding is inconsistent with a prospective evaluation of 29,682 VHD patients between 2001 and 2011 in the UK, of which 37.5% had mild valve disease.[31] This could be due to delayed referral and surgical interventions in our setup, which is an expected condition where medical care is a scarcity.

Table 3 Aetiologies of VHD Based on Sex, Age, and Types of VHD Among Valvular Heart Disease Patients Registered to the Cardiac Centre of Ethiopia from February 2000 to April 2022 (N = 3257)

Category		Etiologies of VHD				Total
		Rheumatic	Congenital	Degenerative	Unknown	
Age Category	1–17	590(18.11)	538(16.52)	5(0.153)	140(4.3)	1273(39.08)
	18–44	1073(32.94)	225(6.9)	12(0.37)	163(5)	1473(45.2)
	45–54	148(4.54)	15(0.46)	5(0.153)	21(0.65)	189(5.8)
	55–64	82(2.52)	13(0.4)	10(0.3)	13(0.4)	118(3.62)
	65–74	71(2.2)	16(0.5)	13(0.4)	12(0.37)	112(3.43)
	≥75	51(1.56)	21(0.65)	14(0.43)	6(0.18)	92(2.82)
	Total	2015(61.9)	828(25.42)	59(1.81)	355(10.9)	3257(100)
Sex Category	Male	803(24.65)	352(10.8)	29(0.9)	145(4.45)	1329(40.8)
	Female	1212(37.2)	476(14.6)	30(0.92)	210(6.5)	1928(59.2)
	Total	2015(61.9)	828(25.42)	59(1.81)	355(10.9)	3257(100)
Types of VHD	AS	35(1.07)	24(0.73)	6(0.18)	5(0.153)	70(2.1)
	AR	57(1.75)	37(1.14)	6(0.18)	25(0.77)	125(3.8)
	MS	262(8)	30(0.92)	4(0.122)	50(1.53)	346(10.6)
	MR	276(8.5)	126(3.9)	10(0.3)	54(1.66)	466(14.3)
	PS	57(1.75)	376(11.54)	4(0.122)	51(1.56)	488(15)
	PR	3(0.09)	11(0.34)	0(0)	1(0.03)	15(0.5)
	TR	40(1.22)	75(2.3)	3(0.09)	17(0.52)	135(4.1)
	Multiple VHD	1285(39.4)	149(4.6)	26(0.34)	152(4.67)	1612(49.5)
	Total	2015(61.9)	828(25.42)	59(0.8)	355(10.9)	3257(100)

Abbreviations: AS, Aortic stenosis; AR, Aortic regurgitation; MS, Mitral stenosis; MR, Mitral regurgitation; PS, Pulmonary stenosis; PR, Pulmonary regurgitation; TR, Tricuspid regurgitation; Multiple VHD, Multiple valvular heart disease.

The most common etiology of VHD as found in this study was rheumatic 61.87%. In line with the current finding, in a population-based survey involving 34,994 people in China, 1309 participants were diagnosed with VHD, and among those participants with VHD, 55.1% of the etiology of VHD was rheumatic.[10] A similar study conducted in Turkey reported rheumatic origin was the main cause of all VHDs.[32] Similar findings from Brazil also supported that rheumatic was the common etiology of VHD (60.3%) which are in line with the current study.[33] Contrary to what has been reported from developed countries, calcific and degenerative valve diseases are on the rise as a result of population aging, while the prevalence of rheumatic heart disease has decreased in these countries.[34] This study reported that degenerative valve disease etiology accounts for 1.81% of all cases. The prevalence of this condition is higher in individuals aged >75 years. The reason for the highest rheumatic cause of VHD in this study might be related to rheumatism, which mainly affects people living in poverty with poor access to health care and unchecked exposure to Group A *Streptococcus* bacteria.[35,36]

This study also reported that congenital was the second most common etiology of VHD, after rheumatic etiology, accounting for 25.42% of all etiologies. This finding is in agreement with a study conducted at Ibrahim Cardiac Hospital & Research Institute, Bangladesh, where congenital etiology accounted for 24.7% of all cases.[37]

In the present study, more females than males overall had VHD. In particular, MS and MR were twice more common in females than in men, which is in line with studies conducted in the UK, Brazil and Turkey.[31–33] This might be due to differences in hormones, which are key mediators of rheumatic disease progression. Estrogen exposure in females is a risk factor for rheumatic disease development.[38]

Strengths and Limitations of the Study

The main strength of this study is that it analyzed 22 years of retrospective data of VHD patients from all age groups and comparatively large sample size. It is also a good indicator of the prevalence and etiology of VHD in the cardiac center in Ethiopia. However, a limitation of this study is that the data were collected from a single institution, which makes it

difficult to draw generalizations at a national level. Data were also gathered from patients' medical records, which lacked sufficient supporting documentation.

Conclusion

In conclusion, VHD affects nearly one-third of all cardiac cases admitted to the hospital. Multi-valvular involvement is the most commonly diagnosed form of VHD. Females were more likely to be affected by VHD than males. Rheumatic causes were more prevalent in this study. Pulmonary hypertension was present in more than half of the patients with VHD. As found in this study, VHD affects young and adult populations, which in turn could have an impact on the country's economy. Large-scale studies focusing on VHD should be conducted at the national level to further explore the magnitude and burden of VHD and develop a mechanism of intervention for this rising health problem.

Abbreviation

RHD, Rheumatic heart disease; VHD, Valvular heart disease; MAVD, Mixed aortic valve disease; AS, Atrial stenosis; TS, Tricuspid stenosis; MS, Mitral stenosis; PS, Pulmonary stenosis; AR, Aortic regurgitation; MR, Mitral regurgitation; TR, Tricuspid regurgitation; PR, Pulmonary regurgitation; NRVHD, Non-rheumatic valvular heart disease.

Data Sharing Statement

The corresponding author can provide the datasets used and/or analyzed during the current study upon reasonable request.

Ethics Approval

The Addis Ababa University College of Health Sciences' Institutional Review Board granted ethical approval for this study. A support letter was also provided to the Cardiac Center of Ethiopia. Participants in the study provided written informed consent. The study was carried out according to the Helsinki Declaration.

Acknowledgment

For providing the facilities required to carry out this research, we are grateful to the study participants and the staff of the cardiac center in Ethiopia.

Disclosure

The authors declare that they have no competing interests.

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