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Pattern of pulmonary hypertension and its associated factors among patients on follow up at Saint Paul's Hospital Millennium Medical College, Addis Ababa, Ethiopia, 2024

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Abstract

Background: Pulmonary hypertension (PH) is a heterogeneous group of diseases that leads to impaired health related quality of life and early mortality. Because of the variability of etiological factors, there is a higher prevalence of PH in developing countries like Ethiopia. Although the prevalence, morbidity and mortality associated with PH are significant in our part of the world, little is known about its epidemiology & distribution in Africa. Our study aiming at assessing the patterns of pulmonary hypertension and its associated factors has been conducted and it would be used as an input to fill this gap.

Objective: To examine the pattern of pulmonary hypertension and identify associated factors in patients having follow up at Saint Paul's Hospital Millennium Medical College (SPHMMC), Addis Ababa, Ethiopia from March, 15 to June, 15 2024 G.C

Methods: Institutional based cross sectional study was conducted over the period of three months from March, 15 to June 15, 2024 at SPHMMC. The collected data was entered into the version 4.7 of EpiData and imported to Statistical SPSS version 25 software for analysis. Descriptive statistics has been employed for sociodemographic characteristics of the respondents. Logistic regression was applied to identify associated factors of pulmonary hypertension.

Result: A total of 152 participants were included in the study. The age ranged from 16 to 86 years. The mean (SD) age of the study participants was 49.8 ± 15.3 years. More than half of the participants were female (59.2%) and from urban areas (55.3%). Pulmonary hypertension due to left heart disease was the most common form (54.6%) followed by PH due to lung disease (24.3%), Group 1 PH (19.1%), Group 5 PH with 3 cases and one patient with CTEPH. Heart failure with reduced ejection fraction was the most common etiology among Group 2 PH-LHD. 21% of the participants presented with HIV and 40.5% of patients have severe PH (PASP>70mmhg). Age, systemic arterial hypertension, history of COPD and right atrial dilation (RAD>44mm) are statistically associated with pulmonary hypertension.

Conclusion: The present study showed that the prevalence of PH-LHD in our set up is relatively higher. The distribution characteristics of the disease could be related to the region-specific differences of the causative diseases.

Key words: High blood pressure in the pulmonary arteries, Echocardiography, Pulmonary Function Tests

Abbreviations/Acronyms

CI Cardiac index

CHD Congenital heart disease

COPD Chronic obstructive pulmonary disease

CPFE Combined pulmonary fibrosis and emphysema

CTEPH Chronic thrombo-embolic pulmonary hypertension

ECHO Echocardiography

HF Heart failure

HIV Human immunodeficiency virus

ILD Interstitial lung disease

mPAP Mean pulmonary arterial pressure

PAH Pulmonary arterial hypertension

PH Pulmonary hypertension

PHLD PH associated with lung diseases and/or hypoxia

PH-LHD PH associated with left heart disease

TR Tricuspid regurgitant

TB Tuberculosis

WHO World health organization

WSPH World symposium on pulmonary hypertension

Introduction

Pulmonary hypertension (PH) is a morbid condition that gained recognition in 1973 when the World Health Organization organized its first symposium. The hemodynamic definition was given as mean pulmonary artery pressure>25 mmHg at rest. Dana Point Classification was given during the 4th symposium and the treatment algorithm updated. In 2018, the 6th World Symposium on Pulmonary Hypertension was a landmark as a proposal was made to revise hemodynamic definition and set mean pulmonary arterial pressure (mPAP) threshold at a lower value. (1, 2)

PH is a progressive disease characterized by an elevation of pulmonary artery pressure and pulmonary vascular resistance, leading to right ventricular failure and death. It remains a challenging chronic progressive disease, but the current interest and advent of medical therapy in the last 20 years has significantly changed the perception of medical community in this disease. Although PH is a clinical entity, it has got both hemodynamic and pathological aspects. Hemodynamically it is defined by mPAP greater than 20 mmHg at rest measured by right heart catheterization. (3)

Even if the definitive diagnosis of PH requires right heart catheterization, transthoracic echocardiography (ECHO) has become the standard screening tool for assessing the presence of PH in cohort studies of patients at increased risk of having the disease. The noninvasive assessment of the pulmonary artery pressure is usually estimated by the addition of the trans-tricuspid gradient (obtained by the peak systolic velocity of the tricuspid regurgitation and applying the Bernouili formula) to the right atrium pressure. (4, 5)

PH is defined as a tricuspid regurgitant (TR) velocity 2.9 m/sec which translated to a right ventricular pressure above 35 mmHg. A tricuspid regurgitant velocity 3.5 m/sec, which translates into a pulmonary arterial pressure/right ventricular systolic pressure of 50 mmHg, is considered as moderate-to-severe PH. The estimated pulmonary artery systolic pressure by transthoracic ECHO has a good correlation with invasively measured mPAP. (6)

The updated clinical classifications of PH according to the 6th World Symposium on Pulmonary Hypertension (WSPH) task force classify PH into five clinical groups. Group 1, pulmonary arterial hypertension (PAH) includes idiopathic, heritable, and drug-induced PH and is associated with conditions such as human immunodeficiency virus (HIV), schistosomiasis, and congenital heart disease (CHD). It comprises patients with precapillary PH due to distinct underlying disorders who share a similar pulmonary angioproliferative vasculopathy that predominantly affects the precapillary arterioles. (7, 8, 9)

Group 2, PH associated with left heart disease (PH-LHD) represents the most prevalent form accounting for 65–80% of case. This includes patients with Heart failure (HF), left-sided valvular heart disease, and congenital/acquired cardiovascular conditions leading to postcapillary PH. The prevalence of PH increases with severity of left-sided valvular diseases. (10)

In 2013, the Global Burden of Disease Study reported 61.7 million cases of HF worldwide, which represented almost a doubling since 1990. Post-capillary PH, either isolated or combined with a pre-capillary component, is a frequent complication mainly in HF, affecting at least 50% of these patients. In patients with valvular heart disease, echocardiographic studies have shown that PH is present in up to 65% of patients with symptomatic aortic stenosis, while virtually all patients with severe mitral valve stenosis develop PH, which can also be found in most patients with significant degenerative or functional mitral regurgitation. (11)

Group 3, PH associated with lung diseases and/or hypoxia (PHLD) is the second most common group following PH-LHD. PH is frequently observed in patients with chronic obstructive pulmonary disease (COPD) and/or emphysema, interstitial lung disease (ILD), combined pulmonary fibrosis and emphysema (CPFE), and hypoventilation syndromes. (12, 13)

In patients with lung disease, PH is categorized as non-

severe or severe, depending on hemodynamic findings. Severe PH is defined by mPAP 35 mmHg or mPAP ≥25 mmHg with cardiac index (CI), 2.5 L/min/m. whereas non-severe PH is common in advanced COPD and ILD defined by spirometric criteria. The clinical symptoms of PH in respiratory diseases are difficult to be picked up as there is a significant overlap with the symptomatology of primary disease. (14, 15, 16)

Group 4, chronic thrombo-embolic PH (CTEPH) is not only a consequence of pulmonary artery obstruction by organized fibrotic clots but can also be related to the associated microvasculopathy. Although group 5, PH with unclear and/or multifactorial mechanism represents less-studied forms of the disease, it constitutes a significant part of the worldwide burden of PH. (17) Cardiovascular diseases were the leading cause of death worldwide, taking an estimated 17.9 million lives, which is equivalent to 31.4% of all deaths. Likewise PH is becoming a major global health issue with estimated global prevalence of 1%. (18)

As of 2015, it was estimated that up to 50–70 million individuals were affected by PH globally, which is expected to rise as global population and life expectancy increases. All age groups are affected. About 30 million individuals are estimated to have HF associated PH, 25 million estimated to have COPD associated PH, 150,000 individuals estimated to have HIV-associated PH, 3.75 million individuals estimated to suffer rheumatic heart disease associated PH, and 2 million individuals estimated to have sickle cell disease associated PH. (19)

Overall, 80% of worldwide CVD related deaths occur in low and middle income countries. In these regions morbid and fatal CVD related events typically occur at an age below 60 and affect more women than in high income countries and, therefore, have a profound impact on the family unit and the workforce. PH is a "not-so-rare" form of heart disease of multiple etiologies in Africa. (20)

Methodology

Study area and period

The study was conducted in the 3 months period from March 15 to June 15 2024 G.C at SPHMMC, Addis Ababa, Ethiopia. The St. Paul's hospital millennium medical college in Addis Ababa is one of the largest hospitals in Ethiopia. It was built by Emperor Haile Selassie in 1961 with the help of the German evangelical church.(37) It aimed to serve primarily low-income patients, and more than 75% of patients are treated free the poor. A medical college was formed in 2007. The hospital is an academic referral hospital; it currently has 392 beds with annual average of 200,000 patients and a catchment population of more than 5 million. There are over 1300 clinical and non-clinical staffs.

It is one of the few tertiary hospitals having advanced cardiology, pulmonary & critical care services, including; intensive care unit which is well equipped & staffed by highly trained healthcare professionals, percutaneous coronary intervention, pacemaker implantation, and percutaneous mitral balloon valvotomy. The cardiology unit has 9 cardiologists, who run 4 outpatient clinics, 3 transthoracic echocardiogram, 1 stress electrocardiogram, 1 transesophageal echocardiogram, 1 dobutamine stress echocardiogram, 2 coronary interventions, and 2 percutaneous mitral balloon valvotomy sessions per week. Patients are referred from all over the country and there are well established regular chest and cardiac clinics with 90 to 100 ECHOs performed weekly. There is also well established chest clinic with 1 pulmonologist & patients with respiratory problems are evaluated at the clinic on weekdays. The study design was institutional based cross sectional study

Source and study population

All patients who has came to SPHMMC adult chest and cardiac clinic for follow up during the study period. The study population consisted selected/sampled members of patients with pulmonary hypertension having follow up at SPHMMC adult chest and cardiac clinic from March 15 to June 15 2024 G.C and who satisfies the following inclusion and exclusion criteria

Inclusion and Exclusion criteria

All patients with the diagnosis of pulmonary hypertension who had follow up at SPHMMC adult chest and cardiac clinic during the study period.

Critically ill patients, Age less than 14 years and Those with incomplete etiological work up/record were excluded from this study.

Sample size determination and sampling procedure

The sample size included all patients who had follow up at SPHMMC adult chest and cardiac clinic during the study period and fulfilled the inclusion & exclusion criteria. The sample size was found to be 152.

Data collection

The patient's data was collected by trained health professionals working in the cardiac & chest clinic. The research assistants or staffs explained the study procedures, conducted eligibility screening and obtained informed verbal and written consent. Before conducting the main study, a pretest has been performed. Data was collected from patients when they came for initial evaluation or follow up. Socio demographic & clinical characteristics were collected from the patients using a structural questionnaire written in English which was a validated tool & customized for this study. In cases when the patient was

unable to give history, data was obtained by enquiring family members accompanying the patient. The 6th WSPH task force guidelines were used to classify PH in to five groups. Data on the clinical diagnosis including investigations regarding to underlying disease etiology & echocardiographic parameters were collected from the patient chart.

Data quality assurance and management

The questionnaire was designed in English language and pre-tested on around 16 patients similar to the study population in the study hospital which were not included in the study. The findings of the pre-test were incorporated into the final instrument for the study. To maintain data quality, data collectors were trained and selected based on educational level, the work experience and knowledge on patients with pulmonary hypertension. The collected data was reviewed and checked for omissions, legibility of handwriting, completeness and consistency by principal investigator on daily bases during data collection time.

Data processing and analysis

The collected data was entered into the latest version of EpiData and double entry was made. The data was cleaned by removing irrelevant data; duplicate our data; fix structural errors, deal with missing data, filter out data outliers and validating our data. The entered data then imported to Statistical Package for Social Science (SPSS) version 25 software for analysis. Descriptive statistics were employed for sociodemographic characteristics of the respondents. Bivariate analysis was done to identify independent factors. P-value less than 0.2 were considered to select candidate variables for multiple logistic regression models. Finally, multivariable logistic regression was done and then Crude Odds Ratio (COR), Adjusted Odds Ratio (AOR) with 95%CI were employed to determine the associated factors of pulmonary hypertension and P- value less or 0.05 was considered as statically significant.

Ethical consideration

Ethical clearance was obtained from Department and Institutional Review Board (IRB) of St. Paul Hospital Millennium Medical College. The study participants were informed about the study objective and then written consent form was obtained prior to data collection. Every patient's identity was not mentioned. The participants were informed about their rights to refuse his or her participation, ask any question or withdraw at any time during data collection process. The vulnerable groups in our study were protected.

Results

Socio demographic and clinical characterstics of the participants

A total of 152 adult patients followed at Saint Paul's Hospital Millennium Medical College, chest and cardiac clinic from March, 2024 to June, 2024 G.C were enrolled in the study. The age ranged from 16 to 86 years with mean age of study participants being 49.8 years (SD 15.3) & most common age group was 40 to 60 years (44%). More than half of participants were females 90 (59.2%) and from urban areas (55.3%). The most frequent cardiovascular comorbidity identified among the study subjects was history of heart failure 97(63.8%) followed by dyslipidiemia 64 (42.1%). Of all patients, 61 (40.1%) have a history systemic arterial hypertension where as 46 (30.3%) have a history of diabetes mellitus. 21% of the participants were smoker and 32 (21.1%) presents with HIV. History of Tuberculosis was reported by 59 (38.8%) of participants and 19.7% has a history of COPD. (Table 1)

Table 1: Table 1: Socio-demographic and clinical characteristics of patients, Addis Abeba Ethiopia, 2024 (n =152)

Variables		Frequency	Percentage (%)
Age (Mean, SD)		49.8, 15.3	
Gender	Female	90	59.2
	Male	62	40.8
Place of residence	Urban	84	55.3
	Rural	68	44.7
Systemic arterial hypertension	Yes	61	40.1
	No	91	59.9
Diabetes mellitus	Yes	46	30.3
	No	106	69.7
Smoking	Yes	32	21.1
	No	120	78.9
Dyslipidiemia	Yes	64	42.1
	No	88	57,9
Human immunodeficiency virus (HIV)	Reactive	32	21.1
	Non reactive	120	78.9
History of	Yes	97	63.8

Heart failure	No	55	36.2
History of tuberculosis	Yes	59	38.8
	No	93	61.2
History of COPD	Yes	30	19.7
	No	122	80.3

Pattern of pulmonary hypertension among the participants

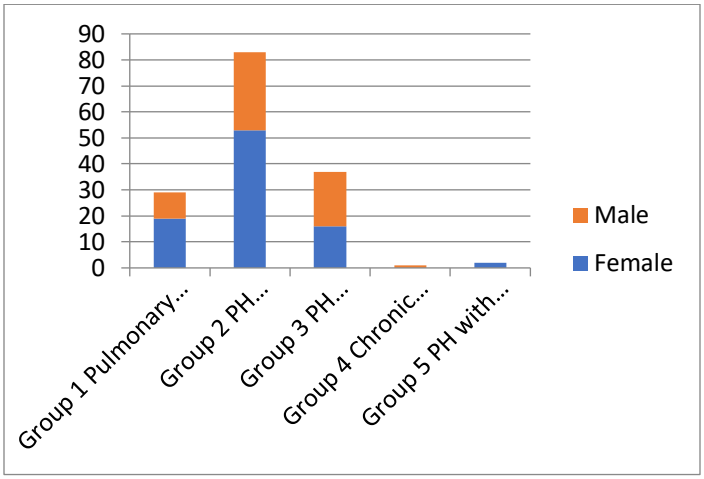
Pulmonary hypertension due to left heart disease (group 2, PH-LHD) was the most common form of PH identified among the participants 83 (54.6%) followed by PH due to lung disease 37(24.3%), Group 1 PH-PAH 29 (19.1%), Group 5 PH 2 (1.3%) and Group 4 CTEPH 1 (0.7%). In the subgroup analysis, Human immunodeficiency virus associated pulmonary arterial hypertension 15 (9.9%) was the most common cause of Group 1 PAH, idiopathic accounts for 8(5.3%) and congenital heart disease for 5 (3.3%). Heart failure with reduced ejection fraction 61(40.1%) was the most frequent subgroup of PH due to left heart disease and valvular heart disease was the cause in 18 (11.8%). In PH due to lung disease, destructive pulmonary tuberculosis was the most common cause 24 (15.8%) followed by COPD 11 (7.2%). (Table 2)

Pulmonary hypertension associated with lung diseases and/or hypoxia was more common in males while Group 1 pulmonary arterial hypertension and PH due to left heart disease were more frequently encountered among the female participants. There were one male patient with Group 4 CTEPH and two females diagnosed with Group 5 PH with unclear and/or multifactorial mechanism. (Figure 1)

Table 2: Pattern of pulmonary hypertension among the participants, Addis Abeba Ethiopia, 2024(n =152)

WSPH Group of pulmonary hypertension (n=152)	Frequency	Percentage (%)
Group 1 PH (Pulmonary arterial hypertension)	**29**	**19.1**
Congenital heart disease	5	3.3
Human immunodeficiency virus-associated	15	9.9
Idiopathic	8	5.3
Associated with Portal hypertension	1	0.7
Group 2 PH associated with left heart disease	**83**	**54.6**
Heart failure with preserved ejection fraction	4	2.6
Heart failure with reduced ejection fraction (EF≤49%)	61	40.1
Valvular heart disease	18	11.8
Group 3 PH associated with lung diseases &or hypoxia	**37**	**24.35**
Chronic obstructive lung disease (COPD)	11	7.2
Post-Tuberculosis bronchiectasis	24	15.8
Lung disease with mixed restrictive/obstructive pattern	2	1.3
Group 4 PH chronic thrombo-embolic PH (CTEPH)	**1**	**0.65**
Chronic thrombo-embolic PH	1	0.65
Group 5 PH with unclear/multifactorial mechanism	**2**	**1.3**
Systemic disorders	1	0.65
Chronic renal failure with or without hemodialysis	1	0.65

Figure 1: Gender based distribution of pulmonary hypertension sub group among participants, Addis Abeba Ethiopia, 2024 (n =152)



Male (n) 10	30	21	1	0
Female (n 19	53	16	0	2

Echocardiography findings of the participants

The median pulmonary artery systolic pressure was 59mmHg (IQR: 49-67 mmHg). Of the entire patients 40.8% presents with severe pulmonary hypertension while 51 (33.6%) have moderate and 39 (25.6%) have mild pulmonary hypertension. The median left ventricular ejection fraction was 50% (IQR 25-70%) and LVEF was below 45% in 36.1% of patients. Echo estimate of the right heart showed 69% of study subjects had evidence of right ventricular dilation and 65.7% had dilated right atrium. The median ventricular wall thickness of participants was 7.01mm. (Table 3)

Table 3: Echocardiographic findings of the patients, Addis Abeba Ethiopia, 2024 (n =152)

Variables		Frequency	Percentage (%)
Pulmonary artery systolic pressure (mmhg), median(IQR)		59 (49-67)	
	Severe PH	62	40.8
	Moderate PH	51	33.6
	Mild PH	39	25.6
Left ventricular ejection fraction (%), Median (IQR)		50 (25-70%)	
Left ventricular ejection fraction below 45%		55	36.1
Right ventricular dilation (>41mm)		105	69
Right Atrial dilation (>44mm)		100	65.7
Median ventricular wall thickness (mm)		7.01	

Factors associated with pulmonary hypertension

For pulmonary hypertension due to left heart disease, age was found to be statistically associated with the odds of developing the disease (AOR=1.96, 95% CI; 0.54-4.87). This implies, as age increases the likelihood or odds of developing pulmonary hypertension due to left heart disease increases. Presence of systemic arterial hypertension also increases the odds of developing pulmonary hypertension due to left heart disease (AOR=2.95, 95% CI; 1.29-4.62). History of COPD disease (AOR=3.19, 95% CI; 1.65-5.94) and right atrial enlargement disease (AOR=2.49, 95% CI; 1.03-4.17) has been found to be strongly associated with the odds of developing Group 3 PH, pulmonary hypertension associated with lung diseases and/or hypoxia. Gender, place of residence and diabetes was not found to be statistically significant. (Table 4 and 5)

Table 4: Factors associated with pulmonary hypertension due to left heart disease among the participants, Addis Abeba Ethiopia, 2024(n =152)

Variable		PH due to Left heart disease		
		No (%)	COR	AOR
Age			2.34(0.63-5.28	1.96(0.54-4.87) *
Gender	Female	53(63.9)	1	
	Male	30(36.1)	1.19(0.35-4.6)	2.35(1.18-4.67)
Place of residence	Urban	58(69.9)	1	
	Rural	25(30.1)	0.35(0.05-2.41)	0.46(0.07-3.21)

Systemic arterial hypertension	Yes	40(48.2)	3.21(1.04-5.82)	2.95(1.29-4.62) *
	No	43(51.8)	1	
Diabetes mellitus	Yes	25(30.1)	1	
	No	58(69.9)	2.74(0.73-10.26)	1.74(0.90-12.36)
History of COPD	Yes	6(7.2)	1	
	No	77(92.8)	0.96(0.83-1.10)	1.43(0.78-2.63)
Right atrial dilation (>44mm)	Yes	45(54.2)	1	
	No	38(45.8)	1.22(0.45-3.29)	1.54(0.89-5.38)

Table 5: Factors associated with pulmonary hypertension due to lung diseases and/or hypoxia among the participants, Addis Abeba Ethiopia, 2024(n =152)

Variable		PH associated with lung diseases and/or hypoxia		
		No (%)	COR	AOR
Age			1.45 (0.26-9.53)	2.17(0.56-8.97)
Gender	Female	16(43.2)	1	
	Male	21(56.8)	1.41(0.122-16.48)	1.24 (0.102-14.59)
Place of residence	Urban	9(24.3)	1	
	Rural	28(75.7)	3.22(0.86-12.75)	2.22(1.96-16.75)
Systemic arterial hypertension	Yes	14(37.8)	1	
	No	23(62.2)	0.48(0.25-1.69)	1.09(0.51-3.84)
Diabetes mellitus	Yes	11(29.7)	1	
	No	26(70.3)	6.31(2.36-18.93)	4.09(3.69-23.71)
History of COPD	Yes	20(54.1)	3.57(1.93-7.21)	3.19(1.65-5.94) *
	No	17(45.9)	1	
Right atrial dilation (>44mm)	Yes	24(64.9)	2.05(0.64-3.78)	2.49(1.03-4.17) *
	No	13(35.1)	1	

Discussion

This was institutional based cross sectional study conducted to determine the pattern of pulmonary hypertension along with its etiological and demographic distribution as well as associated factors, among patients followed at the chest and cardiac clinic of Saint Paul's Hospital Millennium Medical College, from March to June, 2024 G.C. The median age of 49.8 years of patients in our study is similar to the median age of observational study conducted in Somalia (33) but lower than a study from china 71 years (27). This difference could be associated with a lower average life expectancy in Ethiopia and other endemic causes of pulmonary hypertension that affect the age distribution of the patient. The female-to-male ratio of 1.5:1 is comparable to 1.6:1 in the PAPUCO cohort. (31)

Our study showed pulmonary hypertension associated with left heart disease (PH-LHD) was the most common form (54.6%). This is consistent with other studies conducted in Africa, PAPUCO (52%) and Somalia (58%). (31, 33) In addition a meta-analysis on pulmonary hypertension in Africa revealed; left heart disease to be the most common etiologic cause. (5) However studies from United Arab Emirates and India reported Group 1 pulmonary arterial hypertension as the commonest type of PH. Our findings can be explained by the high prevalence of heart diseases African countries. Untreated hypertensive heart disease is a leading cause of heart disease, which is highly common in the African population. (38) In our study, hypertension was detected in 40.1% of the patients. In addition, rheumatic valvular disease which develops due to untreated streptococcal infections is much more frequently seen in the African continent compared to developed countries. (39)

In the PAPUCO study (31), which was a multinational study on PH epidemiology in Africa, Group 2 PH constituted the largest group (69%), followed by group 1 PH (16%), group

3 PH (11%), group 4 PH (2%), and group 5 PH (2%). Although these results were in agreement to our findings, the prevalence of group 3 PH was relatively higher in our study (24.3% Vs 11%). This finding may be associated with a high rate of post-tuberculosis sequelae in a subgroup analysis (15.8%) in Ethiopia, higher number of patients with history of smoking (21%) and with the fact that the study has included patients having followed up at the chest clinic.

In a large meta-analysis, the global prevalence of PH among HIV-infected adults was found 8.3%. (5) Pulmonary hypertension due to HIV is known to be common in the African population. This study found that 21% of patients are reactive for HIV which is comparable to the report from PAPUCO cohort study 30% and similar study conducted in Ethiopia also showed 14% prevalence of PH among HIV infected individuals. However these findings are higher when compared to observational studies conducted at India and Somalia. This inconsistency may be due to the difference in religious sensitivities and availability of HAART in the study community. Our study also showed significant number of the participants had diabetes mellitus (30.3%) and dyslipidiemia (42.1%) which can be associated with a higher percentage of the patients being from urban areas compared to other studies conducted in Africa.

In consistent to a retrospective study conducted in Ethiopia, majority of the participants have severe PH (40.5% Vs 47%). Relatively lower percentage of patients have left ventricular ejection fraction below 45% when compared to a study conducted in USA (36.1% Vs 44%). This discrepancy may be due to a difference on the underlying etiological distribution of PH among the study subjects. According to our study; Age, systemic arterial hypertension, history of COPD and right atrial dilation have association to the development of Group 2 and Group 3 pulmonary hypertension. Similar results have also been reported from other studies conducted at USA, China and India. (26, 27, 28)

It should also be noted that Addis Ababa is at an altitude of 7800 feet where reduced oxygen tension could contribute to elevation of PA pressure. However, population-based studies of Ethiopians living in the Simien plateau in Northern Ethiopia suggest that native Ethiopians living at high altitude have evolved to maintain near normal oxygen saturation. (40)

Conclusion

Over all left heart disease was the most common cause of pulmonary hypertension in our set up. There is a high burden of HIV and tuberculosis leading to destructive lung disease such as fibrocavitation, bronchiectasis and chronic hypoxia and the increasing burden of modifiable risk factors for CVD leading to left heart disease. Age and systemic arterial hypertension are associated with the risk of developing pulmonary hypertension.

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