Magnitude and risks of atrial fibrillation in adult cardiac patients followed at St. Paul's Hospital Millennium Medical College, Addis Ababa: A hospital-based cross-sectional study

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Abstract

Background: Atrial fibrillation (AF) is the most common type of arrhythmia encountered in clinical practice, for which patients are hospitalized. So far, there were few studies conducted on AF in Ethiopia and no studies looked at the magnitude and risk factors of atrial fibrillation among patients with cardiovascular diseases.

Methods: This is a hospital-based cross-sectional study to evaluate the prevalence and risk factors of atrial fibrillation among patients at the cardiac clinic of St. Paul's Hospital Millennium Medical College from February 1st, 2017 to June 30, 2017. A standardized questionnaire was used to collect information on demography, medical history, electrocardiogram, echocardiogram, and use of medications via patient interview and medical record review. Statistical Package for the Social Sciences (SPSS) version 25 was used to analyze the data. Both binary and multivariable logistic regression was used to determine the potential risk factors of AF.

Results: A total of 402 cardiac patients were included in the study. Of these, females accounted for 59.7%. The mean age of the study population was 52 years. The mean systolic blood pressure was 117 mmHg. The majority (99%) of patients were nonsmokers. Atrial fibrillation was detected among 175 (43.5%) patients. Of these, 104 (59.4%) patients had valvular atrial fibrillation. The most frequent causes of cardiovascular diseases among the participants were rheumatic heart disease and hypertension observed in 50.4% and 16.0% of patients respectively. Dyslipidemia, rheumatic heart disease, and degenerative valve disease were independently associated with AF in this population.

Conclusion: Atrial fibrillation was prevalent among patients with cardiovascular disease at St. Paul's Hospital Millennium Medical College. The risk factors independently associated with AF were valvular heart disease and dyslipidemia.

Keywords: Addis Ababa, Atrial fibrillation; Cardiovascuar disease; Ethiopia; Magnitude; Risk factor

Background

Atrial fibrillation (AF) is a supraventricular arrhythmia characterized electrocardiographically by low-amplitude baseline oscillations (fibrillary or f-waves) and an irregularly irregular ventricular rhythm.[1] One-third of arrhythmia-related hospitalizations are for AF. It is associated with an approximately five-fold increase in the risk for stroke and a two-fold increase in the risk for all-cause mortality.[2] Globally, the prevalence of AF is about 1–3% in the general population but rises with age, presence of comorbidities a, and male sex.[3, 4] In hospital-based studies, the prevalence of AF ranges from 0.7% to 55.7%.[5] A study from Jimma town of Ethiopia reported a prevalence of 4.3% among adults over 40 years of age. The study also identified male sex, current smoking, hypertension, and higher body mass index as risk factors for AF.[6] The study did not involve adults under the age of 40. Therefore, it might not reflect the true prevalence of AF among adults. Another study from Addis Ababa reported a prevalence of 46.8% among patients with rheumatic heart disease.[7] It was a retrospective hospital-based study and involved only patients with rheumatic heart disease. Therefore, the study does not represent the true prevalence among patients with other cardiovascular diseases. AF is reported to be higher among patients with cardiovascular disease.[8] It is the most common sustained cardiac arrhythmia and carries an increased risk of stroke, hospitalization, and mortality.[9] AF is also associated with heart failure, frequent physicians or emergency department visits, hospitalization, and significant economic consequences.[10]

To our best knowledge, no previous study assessed the prevalence and risk factors of AF among patients with overall cardiovascular diseases in Ethiopia. Accordingly, we investigated the magnitude and risk factors of AF among patients with cardiovascular diseases at St. Paul's Hospital Millennium Medical College cardiac clinic. The findings of the study are important in designing strategies to combat the disease burden and planning effective treatment.

Methods and Materials

Study setting, design, period, and population

This is a hospital-based cross-sectional study to evaluate the prevalence and risk factors of atrial fibrillation among patients with cardiovascular diseases at St. Paul's Hospital Millennium Medical College from February 1st to June 30, 2017. The sample was collected using a systematic sampling technique among patients on follow-up at the cardiac clinic of St. Paul's Hospital. One of the first or second patients was selected using simple random sampling. Then every other patient was selected using systematic random sampling until the total sample size was attained. If a patient refused, the next immediate patient was included in the study.

Data collection methods

Data were collected using a structured questionnaire to assess socio-demographic information, risk factors for atrial fibrillation, admissions history and anticoagulation status. Electrocardiography (ECG) examination was mandatory and additional investigations like echocardiography and thyroid function were evaluated. Patients with AF were classified based on the duration of onset as; paroxysmal when AF terminated spontaneously or with intervention within seven days of onset, persistent when it failed to self-terminate within seven days, long-standing persistent when it had lasted for more than 12 months, and permanent when individuals with persistent AF were considered no longer suitable for a rhythm control strategy with a joint decision of the patient and physician.[6] Similarly, AF was classified as valvular and non-valvular based on the underlying valve lesion. Valvular AF was considered when AF occurred in association with a prosthetic heart valve, valve repair, or moderate to severe mitral stenosis (related to rheumatic or degenerative valve disease) and non-valvular AF for the rest.[6]

Data Analysis

Each completed questionnaire was entered into SPSS version 20 statistical software and then prepared for analysis. Frequencies and cross-tabulations were used to summarize descriptive statistics of the data and tables and graphs were used for data presentation. A binary logistic regression model assessed the statistical association

between the dependent variable (presence or absence atrial fibrillation) and independent variables. Finally, a p-value <0.05 in both binary and multivariable logistic regression momodelsas is considered significant.

Results

Socio-demographic characteristics of the respondents

A total of 402 patients on follow-up having cardiovascular diseases were included in the study. Of these, 240 (59.7%) were females with a male to female ratio of 1:1.5. The mean age of the study participants was 52.1±16.5 (SD) years. The mean age among patients with AF was 52.7±16.7 (SD) years and there was no significant difference between patients with AF and without AF (p=0.48). Two hundred nineteen (54.5%) patients were from Addis Ababa and the rest were from Oromia, Amhara, and Southern Nations and Nationalities people. There was no significant difference in the distribution of AF between those from Addis Ababa and outside of Addis Ababa (p= 0.23). Regarding ethnicity, 46% and 37.3% of participants were from Oromo and Amhara respectively. The cardiovascular risk factors identified were hypertension, dyslipidemia, and diabetes mellitus reported in 32.6%, 12.7%, and 4.5% of patients respectively. In our study, atrial fibrillation was reported in a higher proportion of participants with dyslipidemia as compared to those without dyslipidemia (p<0.001). The anthropometric assessment showed obesity in 50 (12.4%) patients with a body mass index of ≥ 30 kg/m2. Forty-eight (11.9%) patients had at least one hospitalization over the preceding 12 months. Of those hospitalized, heart failure and cardio-embolic stroke were reported in 32 (8%) and 4 (1%) patients respectively (Table 1).

Characteristics of laboratory findings and underlying heart diseases

Based on 12-lead ECG studies, the prevalence of atrial fibrillation among the study participants was 43.5%. The majority were in the age groups; 60-69, 50-59, and 30-39 years in 27.4%, 16.6%, and 16% respectively. One hundred twelve (64%) patients with AF were females. Based on the underlying heart disease, AF was classified as valvular in 104 (59.4%) patients. Rheumatic heart disease was the cause of valvular AF in 79.8% (83/104) patients followed by degenerative valve disease in the rest 20.2% (21/104). The prevalence of atrial fibrillation was significantly higher among patients with rheumatic heart disease and degenerative valve disease than those without rheumatic and degenerative valve disease respectively (p<0.001 and p=0.01 respectively). Based on the duration of onset, paroxysmal, persistent, and permanent AF were found in 2.9%, 21.1%, and 51.4% of participants. Among patients with non-valvular AF, a CHA_2-DS_2-VASc score ≥ 2 was identified in 73.2% (52/71) of patients (Table 2).

The ECG studies of participants also showed left ventricular hypertrophy, ST-T changes, and left bundle branch block in 18%, 5%, and 2% of patients respectively. Echocardiography studies revealed thrombus in the left atrium in 9 (2.2%) patients. The mean left atrial diameter was 43.8mm and the mean left ventricular ejection fraction was 53.9%. The most common underlying heart diseases were; rheumatic heart disease, hypertensive heart disease, and ischemic heart disease in 29.6%, 19.9%, and 13.9% of participants respectively (Table 3).

Table1: Clinical baseline characteristics of the study population, St. Paul's Hospital Millennium Medical College, Addis Ababa, Ethiopia, 2017 (n=402)

Characteristic		N (%)
Age, years	<30	48 (11.9)
	30-39	59 (14.7)
	40-49	48 (11.9)
	50-59	78 (19.4)
	60-69	109 (27.1)
	70-79	41 (10.2)
	≥80	19 (4.7)
Sex	Female	240 (59.7)
	Male	162 (40.3)
Address	Addis Ababa	219 (54.5)
	Oromia	145 (36.1)
	Amhara	12 (3.0)
	SNNP	25 (6.2)
~~	Addis Ababa	219 (54.5)
	Outside Addis Ababa	183 (45.5)
Ethnicity	Oromo	185 (46.0)
	Amhara	150 (37.3)
	Tigre	8 (2.0)
	Silte	20 (5.0)
	Others†	39 (9.7)
Cardiovascular risk factors	Hypertension	131 (32.6)
	Dyslipidemia	51 (12.7)
	Diabetes mellitus	18 (4.5)
	Current smoking	4 (1.0)
	Prior stroke	4 (1.0)
Body mass index (kg/m^2), mean ± SD		28.86 ± 9.9
Obesity (body mass index ≥ 30 kg/m^2), n (%)		50 (12.4)
Duration of follow-up (years), mean ±SD		2.30± 2.28
Hospitalization over the past 12 months, n (%)		48 (11.9)
Heart failure hospitalization over the past 12 months, n (%)		32 (8.0)
Ischemic stroke (cardio-embolic) over the past 12 months, n (%)		4 (1.0)

Kg: Kilogram; m: meter; LVEF: left ventricular ejection fraction; n: number of participants; SD: standard deviation; †Adere, Afar, Agew, Gurage, Kenbata, Sidama,

Wolayita, Hadya, and Yem; SNNP: South Nations and Nationalities People.

Table2: Characteristics of participants with atrial fibrillation, St. Paul's Hospital Millennium Medical College, Addis Ababa, Ethiopia, 2017

Variable		Frequency (%) N=175 (100)
Age, years, n (%)	<30	21 (12.0)
	30-39	28 (16.0)
	40-49	17 (9.7)
	50-59	29 (16.6)
	60-69	48 (27.4)
	70-79	25 (14.3)
	≥80	7 (4.0)
Sex, n (%)	Female	112 (64.0)
	Male	63 (36.0)
Type of AF, n (%)	**Based on underlying heart disease**	
	Valvular§	104 (59.4)
	Rheumatic heart disease	83 (47.4)
	Degenerative valve disease	21 (12.0)
	Non-valvular	71(40.6)
	CHA_2-DS_2-VASc score, mean ± SD	2.5 ± 0.8
	CHA_2-DS_2-VASc score ≥ 2	52 (29.7)
	CHA_2-DS_2-VASc score < 2	19 (10.8)
	Based on the duration of onset¶	
	Paroxysmal	5 (2.9)
	Persistent	80 (45.7)
	Permanent	90 (51.4)

AF: atrial fibrillation; §valvular AF: considered for AF associated with moderate to severe mitral stenosis; CHA_2-DS2-VASc stands for Congestive heart failure, Hypertension, Age ≥75 years [doubled], Diabetes mellitus, prior stroke or TIA [doubled]; ¶paroxysmal: AF that terminates spontaneously or with intervention within seven days of onset; persistent: AF that fails to self-terminate within seven days; Permanent: AF that has lasted for more than 12 months and agreed upon rate control strategy by both the physician and patient.

Table 3: Laboratory findings and underlying heart diseases of the study population, St. Paul's Hospital Millennium Medical College, Addis Ababa, Ethiopia, 2017

Variable		Value (%)
ECG findings, n (%)	Atrial fibrillation	175 (43.5)
	Left ventricular hypertrophy	72 (18.0)
	ST-T abnormalities	20 (5.0)
	Left bundle branch block	8 (2.0)
	Left atrial enlargement	5 (1.2)
	Normal ECG	122 (30.3)
Echocardiographic findings	Left atrium diameter (mm), mean ±SD	43.8± 10.9
	Thrombus in the left atrium, n (%)	9 (2.2)
	Left ventricular hypertrophy, n (%)	80 (19.9)
	Left ventricular diastolic dysfunction, n (%)	122 (30.3)
	LVEF (%), mean ±SD	53.9± 15.1
	LVEF < 40%, n (%)	67 (16.7)
	LVEF = 40–49%, n (%)	38 (9.5)
	LVEF ≥ 50%, n (%)	254 (63.2)
Heart diseases and etiologies, n (%)	Hypertensive heart disease	80 (19.9)
	Rheumatic heart disease	119 (29.6)
	Degenerative valve disease	27 (6.7)
	Idiopathic dilated cardiomyopathy	34 (8.5)
	Ischemic heart disease	56 (13.9)
	Pulmonary hypertension	31 (7.7)
	Congenital heart disease	12 (3.0)

ECG: electrocardiogram; ST-T: ST-segment and T-wave; LVEF: left ventricular ejection fraction; n: number of participants; SD: standard deviation

The pattern of drug treatment

Beta-blockers, loop diuretics, and angiotensin-converting enzyme inhibitors (ACEIs)/ angiotensin receptor blockers (ARBs) were used in 233 (55.5%), 187 (46.5%), and 175 (43.5%) patients respectively. Digoxin was utilized in 5 (1.2%) patients in combination with beta-blockers for heart rate control. There was no use of non-dihydropyridine calcium channel blockers among the study subjects. The two anti-thrombotic therapies used among the study subjects were vitamin K antagonist (VKA) and low dose acetylsalicylic acid (ASA) in 131 (32.6%) and 84 (20.9%) participants respectively. Four patients had cardio-embolic stoke in the previous 12 months associated with rheumatic valvular AF. Among patients with atrial fibrillation, anticoagulant therapy was recommended in 156 (89.1%) patients. Of these, 131 (84%) patients were on VKA during the study period. Of the remaining 25 (16%) patients; 13 had limited access to International Normalized Ratio (INR) testing, 7 had contraindications, and 5 were not prescribed the medication. Among patients on VKA, those who achieved target INR of 2-3 were 28 (21.4%) patients and the remaining 103 (78.6%) patients had INR below 2 during the previous 6 months. Among patients with non-valvular atrial fibrillation, 52 (73.2%) participants had a CHA_2-DS_2-VASc score ≥2. Of these, 34 (65.4%) were on VKA and the remaining 18 (34.6) were not on anticoagulant treatment (Table 4).

Table 4: Pattern of drug utilization among the study population, St. Paul's Hospital Millennium Medical College, Addis Ababa, Ethiopia, 2017

Drug	Overall (N=402)	Atrial fibrillation (N=175)	No atrial fibrillation (N=227)
Beta-blocker (BB), n (%)	223 (55.5)	144 (82.3)	79 (34.8)
Digoxin plus BB, n (%)	5 (1.2)	4 (2.3)	1 (0.4)
CCB, n (%)	14 (3.5)	-	14 (6.2)
ACEI/ARB, n (%)	175 (43.5)	38 (21.7)	137 (60.3)
Loop diuretics, n (%)	187 (46.5)	134 (76.6)	53 (23.3)
Thiazides, n (%)	92 (22.9)	16 (9.1)	76 (33.5)
Spironolactone, n (%)	60 (14.9)	39 (22.3)	21 (9.2)
VKA, n (%)	131 (32.6)	120 (68.6)	11 (4.8)
ASA, n (%)	84 (20.9)	18 (10.3)	66 (29.1)
Statins, n (%)	53 (13.2)	36 (20.6)	17 (7.5)

ACEI: Angiotensin-converting enzyme inhibitor; ARB: Angiotensin receptor blocker; ASA: Acetylsalicylic acid; VKA: vitamin K antagonist; CCB: Calcium channel blockers

Factors associated with atrial fibrillation

Logistic regression analysis revealed that dyslipidemia, rheumatic heart disease and degenerative valve disease were independent risk factors for AF. However, hypertension was associated with a low risk of AF; whereas age, sex, current smoking, diabetes mellitus, higher body mass index and history of stroke were not associated with AF *(Supplementary Table 1)*.

Discussions

This study determined the magnitude and risk factor profiles of AF among patients with cardiovascular diseases at the cardiac clinic of St. Paul's Hospital Millennium Medical College in Addis Ababa. The study showed an AF prevalence of 43.5% among adults with cardiovascular diseases. The study also revealed that rheumatic heart disease, degenerative valve disease and dyslipidemia were the independent risk factors for AF. However, hypertension was found to be associated with a lesser risk of AF than non-hypertensive patients.

Our study showed a higher prevalence of AF compared to several studies from Sub-Saharan Africa.[12-15] Of these, a prevalence of 20.8% in the THESUS-HF study, 4.6% in a hospital-based study in South Africa, 5.9% in a hospital in Burkina Faso and 5.4% in Senegal were the frequently cited studies (7,8,9,10).

The difference might be related to the presence of a higher number of patients with valvular heart disease in our study that could contribute to the higher prevalence of AF. In addition, the lack of definitive valve repair or replacement for the majority of our patients may predispose them to severe disease complicated by atrial fibrillation.

Consistent with previous reports,[11, 15] rheumatic heart disease, degenerative heart disease and dyslipidemia were found to be the independent risk factors for AF. However, hypertension was associated with a lower risk of AF than those without hypertension. This finding contradicts the well-known fact that hypertension is associated with a 1.5 to 1.8 fold increase in the risk of developing AF.[16] The possible explanation for the lack of positive association in our study could be due to a small number of patients with hypertension and/or the presence of adequate control of hypertension, which is known to reduce the development of AF.[17]

In contrast to other studies,[18-20] old age, sex, current smoking, diabetes mellitus, higher body mass index and history of stroke were not associated with AF in our study. The reason for not showing ing significant difference might be due to the small sample size in our study. Our result indicated that patients with valvular heart disease were four times more likely to develop AF than those without primary valve disease, even more in patients with rheumatic heart disease than degenerative valve disease. Similar findings were reported by Charles et al. and in the THESUS-HF study that valvular heart disease was associated with the incidence of AF, with more than a 2-fold increased risk of AF attributed to valvular heart disease.[11, 15] Similarly, data from the Framingham Heart Study revealed that valvular disease was associated with a two to threefold increase of risk of AF.[11]

Comparable to a study from India,[21] the magnitude of valvular AF in the present study was high (59.4%). However, the proportion of valvular AF was lower in other studies from Sub-Saharan Africa ranging from 9.9% to 44%.[11-15] The differences might be attributed to the differences in the underlying cause of heart disease. Similar to a study from a developing country,[22] permanent AF was the most prevalent type of AF in our study, possibly due to the less likelihood of detection of AF when it is paroxysmal and the frequency of using rhythm control strategy in our set up is lower than the developed world.[23]

In our study, rheumatic heart disease was the most prevalent coexisting medical condition, observed in 69.7% of the AF sub-population. This is higher than the findings from several recent studies from developing countries that have documented rheumatic heart disease as a coexisting medical condition in 23.9% to 44% of participants.[11, 15, 24-26] The major comorbidity in the other studies was hypertension. However, a study conducted in a similar setting in Ethiopia two decades ago showed rheumatic heart disease as the most common comorbidity followed by hypertension among patients with atrial fibrillation.[27] This might be due to the differences in the study setting, patient population, and smaller sample size in our study. Our study was conducted in a public institution that serves patients from the lower socio-economic class where rheumatic heart disease is expected to be more prevalent.

Since local guidelines are not available for the management of AF in our setup, it is the decision of treating physicians who choose either a rate or rhythm-control strategy. This was based on drug availability, physician preference or international guidelines recommendations. Unlike several studies from Sub-Saharan Africa,[11-15, 22, 24] our patients were offered only a rate control strategy with beta-blockers and digitalis. A rate control strategy was considered mainly for economic reasons and appears more realistic for our patients who had low income. Furthermore, anti-arrhythmic drugs were not widely available in Ethiopia.

In the current study, we used the CHA_2DS_2-VASc score to evaluate the anticoagulant requirement of participants with non-valvular atrial fibrillation. Based on the 2016 European Society of Cardiology guideline for the management of atrial fibrillation, anticoagulation is recommended when a CHA_2DS_2-VASc score ≥2 for men and ≥3 for women.[28] Regarding anticoagulation therapy with VKA, only one-fourth of our patients had therapeutic INR between 2 and 3. This was even lower than other studies,[16, 26, 29] which reported therapeutic INR in one-third of their patients. This may be because of limited access to INR testing, poor patient education, and poor awareness by both physicians and patients.[30, 31] Strategies to tackle these challenges are needed to improve clinical outcomes with oral anticoagulation. Increasing patient awareness and availing INR testing routinely in public hospitals can be short-term solutions. Although self-monitoring using point-of-care devices may be standard of care in developed countries, they are currently neither available nor affordable for the majority of patients in Africa.[32] Moreover, it is unknown if our patients can effectively self-monitor and adjust their VKA doses.

Our study had some limitations. First, it was a single-center and hospital-based cross-sectional study, which could not reflect the true prevalence of atrial fibrillation in the community. Second, St. Paul's Hospital Millennium Medical College is one of the few national tertiary hospitals where cardiovascular specialty care is practiced in Ethiopia. This can lead to selection bias because only selected and complicated patients with cardiovascular disease are referred to. As a result, the prevalence of atrial fibrillation might have been overestimated. Thus, a large-scale multi-center study is highly recommended.

In conclusion, there is a high prevalence of atrial fibrillation among cardiac patients at St. Paul's Hospital Millennium Medical College. The most common cardiovascular disorders are valvular heart disease and systemic hypertension. Rheumatic heart disease, degenerative heart disease and dyslipidemia were identified as independent risk factors for AF in this population. The predominant treatment strategy is rate-control using beta-blocker therapy. Stroke risk prevention of AF is inadequate with a significant proportion of patients having sub-therapeutic INR while on VKA. Early screening and treatment of valvular heart disease should be widely implemented in the community to combat the burden of the disease. Local protocols on the management of AF should be developed to improve the outcome and reduce complications among patients with AF. Increasing patient awareness and availing routine INR testing in public hospitals can be short-term solutions.

Abbreviations

AF, Atrial fibrillation; CHA_2-DS_2-VASc, Congestive heart failure, Hypertension, Age ≥75 (doubled), Diabetes, Stroke (doubled), Vascular disease, Age 65 to 74 and Sex category (female); ECG, Electrocardiography; INR, International Normalized Ratio; LVEF, Left ventricular ejection fraction; SD, Standard deviation; SNNP: South Nations and Nationalities People; SPHMMC, St. Paul's Hospital Millennium Medical College; SPSS, Statistical Package for the Social Sciences; THESU-HF, The Sub-Saharan Africa Survey on Heart Failure; VKA, Vitamin K antagonist;

Declaration

Ethics approval and consent to participate

This study was approved by the Institutional Review Board of St. Paul's Hospital Millennium Medical College and all participants signed an informed consent form.

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Authors' contributions

KM conceived and developed the study protocol. AM collected the data. The interpretation was done by HAM, KM, and AA. HAM processed it for publication. All authors approved the final manuscript.

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Competing interest

All authors read and approved the final manuscript. The authors declare that they have no competing interests.

Availability of Data and Materials

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

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