

Prevalence of and Risk Factors for Atrial Fibrillation in Korean Adults Older than 40 Years

Atrial fibrillation (AF) is a common arrhythmia that is a potent independent risk factor for stroke. The incidence of AF increase with age and most affected people have underlying cardiac disease. This study aimed to describe the prevalence of and risk factors for AF in Korean. In this study, 14,540 adults (male 6,573/female 7,967) ≥ 40 yr old received screening test for general health between April 2000 and December 2000. Participants answered questionnaires and underwent examinations that included blood pressure, electrocardiogram (ECG), total cholesterol, and fasting glucose. Data analysis was done by SPSS 10.0 for Windows. The prevalence of AF was 0.7% in people older than 40 yr and 2.1% in those older than 65 yr. The prevalence in men was 1.2% and women was 0.4% in people older than 40 yr. The prevalence in men was 3.3% and women was 1.1% in people older than 65 yr. Approximately 56.6% of individuals with AF are older than 65 yr. The prevalence of AF was higher at all age group in men than in women. Also, the prevalence of AF was highest in people older than 80 yr. In univariate analysis, male sex, old age (≥ 65 yr), hypertension, diabetes mellitus, left ventricular hypertrophy in ECG, stroke, and cardiac disease were associated with an increased risk of AF. In multivariate analysis, however, risk factors of AF were male (odds ratio, OR 4.1; 95% confidence interval [CI] : 2.6 to 6.5; $p=0.000$), old age (OR 5.3; 95% CI:3.5 to 7.9; $p=0.000$), and cardiac disease (OR 19.8; 95% CI:12.3 to 31.8; $p=0.000$). In this study, the most potent risk factors of AF was cardiac disease.

Key Words : Atrial Fibrillation; Prevalence; Risk Factors; Epidemiology

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INTRODUCTION

Atrial fibrillation (AF) is a common arrhythmia that is a potent independent risk factor for stroke and has a significant impact on longevity, approximately doubling all-cause and cardiovascular mortality rates. There are an estimated 2.2 million people in the United States (U.S.) with AF, with a median age of about 75 yr. The prevalence of AF is 2.3% in people older than 40 yr and 5.9% in those older than 65 yr. Approximately 70% of AF are between 65 and 85 yr of age (1). In the Framingham Study (2), the incidence of AF doubles with each advancing decade of age >50 yr and reaches almost 10% in octogenarians. The incidence of AF is higher at all ages in men than women, but with a closing gap with advancing age. After adjusting for age and other risk factors predisposing person to AF, men were 50% more likely than women to develop the rhythm disturbance (3).

In the Framingham Study (4), the most common cardiac precursors of AF were heart failure, myocardial infarction, and valvular heart disease. Adjusting only for age, cigarette smoking in women, and diabetes, hypertension and electrocardiogram (ECG)-left ventricular hypertrophy (LVH) in both sexes

were significant AF predictors. After adjusting for other associated conditions as well as age and sex, diabetes and hypertension remained significant predictors of AF.

In other study (5), among 4,844 participants, 304 developed a first episode of AF during an average follow-up of 3.28 yr, for an incidence of 19.2 per 1,000 person years. The onset was strongly associated with age, male sex, and presence of clinical cardiovascular disease. The use of diuretics, a history of valvular disease, coronary heart disease, advancing age, higher levels of systolic blood pressure, height, glucose, cardiac injury score and left atrial size (≥ 3 cm) were all associated with an increased risk of AF.

In the Korea, the prevalence of and risk factors for AF were not evaluated. This study aimed to describe the prevalence of and risk factors for AF in Korean.

MATERIALS AND METHODS

In this study, 14,540 adults (male 6,573/female 7,967) ≥ 40 yr old inhabitants in 5 cities and 3 counties in Gyeongsangnam-do received screening test for general health between

April 2000 and December 2000 by National Health Insurance Cooperation. All participants answered questionnaires for history of medical illness (hypertension, diabetes mellitus (DM), cardiovascular disease, hyperthyroidism, and so on), smoking, and alcohol drinking and underwent examinations that included blood pressure, ECG, total cholesterol, and fasting glucose.

Blood sampling was done after fasting state at least 12 hr. Plasma total cholesterol and glucose were measured in an autoanalyzer (Automatic analyzer, Hitachi 736-20, Tokyo, Japan) by enzymatic and glucose-oxidase method. The 12-lead resting ECG was done by Auto Cardiner FCP-2201, FCP-2155 (Fukuda Denshi Co., Tokyo, Japan). Hypertension was defined for each examination as a systolic blood pressure of at least 140 mmHg or a diastolic blood pressure of at least 90 mmHg on each of two readings by Joint National Committee criteria VI (JNC VI) (6), or the use of antihypertensive medication. Diabetes mellitus was diagnosed if the subjects had a fasting glucose level of or higher (≥ 126 mg/dL) by ADA (American Diabetes Association) diagnostic criteria (7) or was taking insulin or an oral hypoglycemic agent at the current examination. Hypercholesterolemia was diagnosed if the subjects had a serum total cholesterol level of or higher (≥ 240 mg/dL) by NCEP II (National Cholesterol Education Program II) criteria (8).

Clinical cardiovascular disease at baseline was defined by any of the following: a history of myocardial infarction, angina, stroke, congestive heart failure, valvular heart disease, cardiomyopathy, arrhythmia, aortic dissection, valve replacement surgery. Alcohol drinking was ascertained by self-report and categorized as the weekly alcohol consumption >90 g ethanol. ECG-LVH was considered present if the subject fulfilled voltage criteria (≥ 5 points by Romhilt-Estes criteria) for hypertrophy and manifested lateral repolarization changes. AF was defined by disorganized atrial activity without discrete P waves, atrial activation ranging from 350 to 600 beats per minute, and irregularly irregular ventricular response.

Statistical analysis was done by SPSS 10.0 (Statistical package for the social sciences, SPSS Inc, Chicago, IL, U.S.A.) for Windows and correlation analysis was by chi-square test, contingency coefficient, and Cramer's V. Multivariate analysis was done by multinomial logistic regression test. A *p* value <0.05 was considered statistically significant.

Table 1. Numbers of participants according to age groups & sex

Age groups (yr)	Total (%)	Male (%)	Female (%)
40-49	5,576 (38.4)	2,491 (37.9)	3,085 (38.7)
50-59	3,920 (27.0)	1,830 (27.8)	2,090 (26.2)
60-64	2,168 (14.9)	988 (15.0)	1,180 (14.8)
65-69	1,237 (8.5)	518 (7.9)	719 (9.0)
70-74	1,095 (7.5)	480 (7.3)	615 (7.7)
75-79	369 (2.5)	177 (2.7)	192 (2.4)
≥ 80	175 (1.2)	89 (1.4)	86 (1.1)
Total	14,540 (100)	6,573 (100)	7,967 (100)

RESULTS

A total of 14,540 subjects (6,573 men and 7,967 women) aged 54.6 ± 10.8 (mean age \pm SD) yr (range 40 to 92) were enrolled in this study. Table 1 lists the numbers of participants according to age groups and sex.

The prevalence of AF was 0.7% (106/14,540) in people older than 40 yr and 2.1% (60/2,876) in those older than 65 yr. The prevalence in men was 1.2% (76/6,573) and women was 0.4% (30/7,967) in people older than 40 yr. The prevalence in men was 3.3% (42/1,264) and women was 1.1% (18/1,612) in people older than 65 yr. The mean age of individuals with AF is approximately 65.3 yr.

The prevalence of AF was 3-fold higher in men than in women. The prevalence of AF were 0.1% in aged 40-49 yr, 0.5% in aged 50-59 yr, 0.9% in aged 60-64 yr, 2.2% in aged 65-69 yr, 1.7% in aged 70-74 yr, 1.9% in aged 75-79 yr, 4.0% in over the 80 yr old (Table 2).

The prevalence in men is substantially greater than in women at all ages. Fifty-seven percent of individuals with AF are older than 65 yr. This study showed that the prevalence of AF was the highest among over the 80 yr old (Table 2).

In univariate analysis, old age ($p=0.000$), male ($p=0.000$), hypertension ($p=0.000$), diabetes mellitus ($p=0.006$), cardiac disease ($p=0.000$), ECG-LVH ($p=0.000$), and stroke ($p=0.000$) were significantly associated with an increased risk of AF. However, cigarette smoking ($p=0.780$), alcohol drinking ($p=0.252$), hypercholesterolemia ($p=0.462$), and hyperthyroidism ($p=0.101$) were not associated with an increased risk of AF (Table 3).

After adjustment for age, sex, and other clinical variables, independent risk factors for AF were male (OR 4.1; 95% CI: 2.6 to 6.5; $p=0.000$), old age (OR 5.3; 95% CI: 3.5 to 7.9; $p=0.000$), and cardiac disease (OR 19.8; 95% CI: 12.3 to 31.8; $p=0.000$) in this study. The most potent risk factor of AF was cardiac disease (Table 4).

DISCUSSION

AF is a common arrhythmia that is associated with increased

Table 2. Prevalence of atrial fibrillation according to age groups & sex

Age groups (yr)	Total (%)	Male (%)	Female (%)
40-49	5 (0.1)	3 (0.12)	2 (0.06)
50-59	21 (0.5)	13 (0.7)	8 (0.4)
60-64	20 (0.9)	18 (1.8)	2 (0.2)
65-69	27 (2.2)	20 (3.9)	7 (1.0)
70-74	19 (1.7)	12 (2.5)	7 (1.1)
75-79	7 (1.9)	6 (3.4)	1 (0.5)
≥ 80	7 (4.0)	4 (4.5)	3 (3.5)
Total	106 (0.7)	76 (1.2)	30 (0.4)

* %=numbers of atrial fibrillation/numbers of participants.

Table 3. Analysis of risk factors of atrial fibrillation

Risk factor	ECG (n)*	C. coefficient [†]	Cramer's V	χ^2 (p value)
Age (yr)				
≥65	60/596/2220	0.150	0.152	0.000
40-64	46/1197/10421			
Sex				
Male	76/835/5662	0.047	0.047	0.000
Female	30/958/6979			
Hypertension				
+	29/512/2300	0.087	0.088	0.000
-	77/1281/10341			
Diabetes mellitus				
+	4/108/551	0.026	0.026	0.006
-	102/1685/12090			
Hypercholesterolemia				
+	9/200/1307	0.010	0.010	0.462
-	97/1593/11334			
Smoking				
+	17/290/1964	0.006	0.006	0.780
-	89/1503/10677			
Alcohol drinking				
+	21/269/2047	0.014	0.014	0.252
-	85/1524/10594			
Cardiac disease				
+	31/93/217	0.168	0.170	0.000
-	75/1700/12424			
ECG-LVH [‡]				
+	6/238/0	0.322	0.341	0.000
-	100/1555/12641			
Stroke				
+	3/35/85	0.049	0.050	0.000
-	103/1758/12556			
Hyperthyroidism				
+	1/2/19	0.018	0.018	0.101
-	105/1791/12622			

*ECG (n), Numbers of AF/ abnormal ECG/ normal ECG; [†]C. coefficient, contingency coefficient; [‡]ECG-LVH, electrocardiographic left ventricular hypertrophy.

risk for cardiovascular morbidity and mortality (8-12). Epidemiological and clinical studies (13-16) have generally indicated that AF constitutes a major independent risk factor for stroke, with 3-5 fold increased risk after adjusting for other risk factors. The incidence rose sharply with age, and prevalence of AF increased significantly over a span of 38 or 22 yr (2, 11). In Korea, AF will be serious clinical problem in the future due to substantially increasing of older ages.

AF may occur in both cardiac and noncardiac disease or it may present in the absence of any overt conditions (17, 18). The cardiac causes associated with AF are various types of valvular heart disease (especially, mitral valve disease), acute myocardial infarction, myocarditis, cardiomyopathy (all forms), congenital heart disease, pericarditis, hypertensive cardiovascular disease, sick sinus syndrome, WPW syndrome, and heart failure. Noncardiac causes of AF that have been reported include thyrotoxicosis, alcohol abuse, severe infection, pulmonary

Table 4. Multinomial logistic regression analysis by adjusted risk factors of AF

Risk factor	Odds ratio	95% Confidence interval	p value
Age ≥65 yr	5.3	3.5-7.9	0.000
Male	4.1	2.6-6.5	0.000
Cardiac disease	19.8	12.3-31.8	0.000
Hypertension	0.9	0.6-1.5	0.821
Diabetes mellitus	0.6	0.2-1.7	0.317
ECG-LVH*	0.8	0.4-1.3	0.901
Stroke	2.8	0.8-9.3	0.103

*ECG-LVH, electrocardiographic left ventricular hypertrophy.

embolism, pulmonary hypertension, and chronic obstructive pulmonary disease. Lone AF is, by definition, atrial fibrillation without "overt" structural heart disease. It occurs in approximately 10 percent of chronic AF (19-21).

The morbidity associated with AF is related to 1) excessive ventricular rate, which in turn may lead to hypotension, pulmonary congestion, or angina pectoris in susceptible individuals, and in some patients cause produce a tachycardia-mediated cardiomyopathy; 2) the pause following cessation of AF, which can cause syncope; 3) systemic embolization, which occurs most commonly in patients with rheumatic heart disease; 4) loss of the contribution of atrial contraction to cardiac output, which may cause fatigue due to decrease in ventricular stroke volume of up to 20 to 25 percent; and 5) anxiety secondary to palpitations.

In this study, the prevalence of AF is 0.7% in people older than 40 yr and 2.1% in those older than 65 yr. The mean age of individuals with AF is approximately 65.3 yr. Fifty-seven percent of individuals with AF are older than 65 yr. This results were lower than 2.3% in people older than 40 yr, and 5.9% in those older than 65 yr, with a median age of about 75 yr, and 84% of persons with AF are older than 65 yr in the U.S. study (1). This difference was due to the ratio of population older than 65 yr in population older than 40 yr. In this study, the rate was 19.8% but 32.6% in U.S. study.

In the Framingham study (2), the prevalence of AF were 0.1% in aged 40-49 yr, 0.5% in aged 50-59 yr, 1.8% in aged 60-69 yr, 4.8% in aged 70-79 yr, 8.8% in older than 80 yr. In this study, the prevalence of AF were 0.1% in the 5th decades, 0.5% in the 6th decades, 1.4% in the 7th decades, 1.8% in the 8th decades, 4.0% in older than 80 yr. By comparison with the U.S. study, the prevalence of AF were same in the 5th and the 6th decades. The prevalence of AF, however, were greater in the 8th decades and in older than 80 yr in the U.S. In the Framingham study (2), the prevalence of AF doubles with each advancing decade of age >50 yr and reaches almost 10% in octogenarians. In this study, the prevalence in men is substantially greater than in women at all ages. The prevalence of AF was 3-fold higher in men than in women.

The incidence of AF is higher at all ages in men than women, but with a closing gap with advancing age. After adjusting for age and other risk factors predisposing person to AF,

men were 50% more likely than women to develop the rhythm disturbance (3).

In the Framingham Study (4), the most common cardiac precursors of AF were heart failure, myocardial infarction, and valvular heart disease. These cardiac conditions accounted for 20% of the AF incidence in men and 31% of its occurrence in women. Heart failure imposed the greatest risk of AF, with a 4.5-fold increased risk in men and a 5.9-fold increase in women. Valvular heart disease was associated with a 1.8-fold increase in men and a 3.4-fold increase in women. Myocardial infarction was significantly associated with AF only in men, increasing their risk by 40%. Adjusting only for age, cigarette smoking in women, and diabetes, hypertension and ECG-LVH in both sexes were significant AF predictors. Women who smoked were 40% more likely to develop AF; those who were diabetic had a 2-fold increase risk; those with hypertension had a 70% greater risk; and those with ECG-LVH had almost a 4-fold increase risk. In men, diabetes increased risk 70%, hypertension 80%, and ECG-LVH by 3-fold. After adjusting for other associated factors, as well as age and sex, diabetes and hypertension remained significant predictors of AF. In both age-adjusted and risk factor-adjusted analyses, neither obesity nor alcohol intake were substantial or significant risk factors for AF.

In other study (5), among 4,844 participants, 304 developed a first episode of AF during an average follow-up of 3.28 yr, for an incidence of 19.2 per 1,000 person years. The onset was strongly associated with age, male sex, and presence of clinical cardiovascular disease. The use of diuretics, a history of valvular disease, coronary heart disease, advancing age, higher levels of systolic blood pressure, height, glucose, cardiac injury score and left atrial size (≥ 3 cm) were all associated with an increased risk of AF. However, the use of β blockers and high levels of alcohol use, cholesterol, and forced expiratory volume in 1 sec (FEV₁) were associated with reduced risk of AF.

In this study, male, old age, hypertension, DM, cardiac disease, ECG-LVH, and stroke were significantly associated with an increased risk of AF. However, cigarette smoking, alcohol drinking, hypercholesterolemia, and hyperthyroidism were not associated with an increased risk of AF.

Earlier studies confirmed the role of alcohol as a precipitating factor for new-onset AF (22, 23). The mechanism of alcohol-induced AF is not known, but increased circulating catecholamines, changed conduction and refractory times, vagal reflexes, myocardial damage have been suggested (23, 24). In other study (25), increases in β -adrenoceptor density and low-frequency/high-frequency ratio during ethanol intoxication in patients with AF suggest an exaggerated sympathetic reaction. A controversy exists on the possible changes in adrenergic activity in healthy subjects. In our study, alcohol drinking was not associated with risk factor for AF. This is same result in other studies (4, 5), but more studies were needed.

Hyperthyroidism is a well-known risk factor for atrial fib-

rillation. The incidence of AF was about 10 to 25% of patients who have thyrotoxicosis, it is more common in patients with older and combined cardiovascular disease. The mechanism is shortening of the functional refractory time, β -adrenergic like effect, and direct effect of thyroid hormone. In this study, it was not associated with a risk factor for AF. This result seems due to very low incidence (0.15%) of hyperthyroidism in this study.

In conclusion, independent risk factors for AF were male, old age, and cardiac disease in this study. The most potent risk factor of AF was cardiac disease.

Although the incidence of AF in the Korea was lower than in the United States, AF will be serious clinical problem in the future due to substantially increasing of older ages.

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