Original Article

Prevalence of Atrial Fibrillation in China and Its Risk Factors*

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Abstract

Objective To study the prevalence of atrial fibrillation (AF) and the relation with its risk factors in China.

Methods A total of 19 363 participants (8635 males and 10 728 females) aged ≥35 years in geographically dispersed urban and rural regions of China were included in this cross-sectional survey. All participants received questionnaire, physical and blood examination. Echocardiography were performed for AF patients found in the survey.

Results Of the 19 363 participants, 199 were diagnosed with AF. The estimated age-standardized prevalence of AF was 0.78% in men and 0.76% in women. The prevalence of AF in participants aged <60 years was 0.41% in men and 0.43% in women, and was 1.83% in both men and women aged ≥60 years. About 19.0% of males and 30.9% of females with AF were diagnosed with valve disease. Age- and sex-adjusted multivariable logistic regression analysis revealed that myocardial infarction, left ventricular hypertrophy (LVH), obesity, and alcohol consumption were associated with a increased risk of AF(P<0.05).

Conclusion The age standardized prevalence of AF is 0.77% in the participants enrolled in the present study. The number of AF cases aged ≥35 years is 5.26 million according to 2010 Chinese Census. Most risk factors for AF, identified mainly in Western countries, are also detected in China.

Key words: Atrial fibrillation; Epidemiology; Risk factors; Chinese population

Biomed Environ Sci, 2013; 26(9):709-716 doi: 10.3967/0895-3988.2013.09.001 ISSN:0895-3988

www.besjournal.com(full text) CN: 11-2816/Q

INTRODUCTION

The majority data about the epidemiology of atrial fibrillation (AF) are available from studies in Western Europe and North America, which demonstrate that the incidence of AF increases[1-2] due to the aging of general population in industrialized countries. AF is a major risk factor for stroke, particularly in elderly individuals[3] and associated with the increasing risk of heart failure, dementia, and death[4-8]. The epidemic of AF is a major public health burden in developed countries[9-11].

It was reported that advanced age, male sex, hypertension, heart failure, valve disease, obesity, and prolonged electrocardiographic PR interval are the major risk factors for AF[4,12-14]. So far, only a few reports are available on the epidemiology of AF in

*This work was supported by the 10th National Five-Year Plan Projects (2001BA703B14, and 2001BA703B01) of Ministry of Science and Technology and Ministry of Health.

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Received: September 14, 2012; Accepted: May 7, 2013

China[15-16]. It is, therefore, of utmost importance to improve our knowledge on the epidemiology of AF in China and its risk factors.

In the present study, the prevalence of AF and its associated factors were studied in 10 urban and rural communities of China.

METHODS

Study Subjects

The epidemiology of AF was surveyed in 2004 in 13 populations from the China Multicenter Collaborative Study on Cardiovascular Epidemiology initiated in 1982, including repeated cross-sectional surveys, follow-up studies and surveillance on cardiovascular diseases and its risk factors. Selection of participants was representative of the geographic and economic diversity in China (Figure 1)[17]. Ten of the original 13 subgroups, included in the China multicenter collaborative study on cardiovascular epidemiology, were selected for the present analysis. The 10 subgroups were composed of 4 urban residents groups (Chongwen and Shijingshan in Beijing, Deyang in Sichuan and Mudanjiang in Heilongjiang), 5 rural farmland residents groups (Yuxian in Shanxi, Jintan in Jiangsu, Wuming in Guangxi, Hanzhong in Shaanxi, Panyu in Guangdong),

Figure 1. Geographical distribution of studied populations in China.

and 1 fishing community group (Zhoushan in Zhejiang). The required number of participants reached the selection bias was considered in the selection.

About 1000 individuals aged 35-59 years and 1000 individuals aged ≥60 years were recruited by random cluster sampling based on their household registration data in each defined population. A total of 19 929 residents participated in the survey. Five hundred and sixty-one individuals were excluded due to the missed covariate data (blood glucose, case history on medication, smoking, drinking), 4 individuals with the onset of AF within 12 months after the hyperthyroidism and 1 individual with the onset of AF within 30 days after surgery were also excluded. The study was approved by Ministry of Health and Ministry of Science and technology. Signed informed consent was provided.

Data Collection

Data were collected by trained persons. Data on demographic characteristics, lifestyle factors, medical history, and current medication (antihypertensive and hypoglycemic medication) were collected using standardized questionnaire[18]. Height without shoes was measured to an accuracy of 0.5 centimeter using a vertically fixed tape and a right-angle ruler. Weight without heavy clothing and shoes was weighed to an accuracy of 0.1 kilogram on a standard spring balance. Body mass index (BMI) was calculated as weight in kilogram divided by height in meter squared. Blood pressure at seat was measured 3 times with a mercury sphygmomanometer and the systolic and diastolic pressures were averaged. AF, previous myocardial infarction and LVH on 12-lead resting electrocardiogram were defined according to the standardized clinical electrocardiographic criteria[19]. Fasting blood was collected from each subject. Serum glucose was analyzed by the central laboratories in Beijing and Guangzhou. Individuals with a history of AF or ECG-diagnosed AF underwent 2-dimensional and color Doppler echocardiography at the appointed local hospitals within 3 months after survey.

Definitions of Risk Factors

Myocardial infarction was defined according to the electrocardiogram or the positive history of myocardial infarction. Hypertension was diagnosed when systolic blood pressure was ≥140 mmHg, diastolic blood pressure was ≥90 mmHg, and the antihypertensive medication in the past 2 weeks.

Obesity was defined when the BMI was ≥28 kg/m^2 [20]. Diabetes was diagnosed when the fasting blood glucose level was ≥7.0 mmol/L (126 mg/dL), or the history of medication in the past month. Valvular heart disease was diagnosed according to the stenosis, or at least moderate severity regurgitation detected by echocardiograpy, valve replacement or valvuloplasty. Individuals were classified as smokers if they smoked at least 20 packs of cigarettes in life or smoked at least one cigarette per day for one year, or classified as consuming alcohol if they drank at least one alcoholic beverage per week.

Diagnosis and Definition of AF

AF was diagnosed according to the case history and the electrocardiogram during the survey. In case of a positive answer to the question "Have you ever been diagnosed with AF by a physician?", a detailed medical history of AF was collected using a specific AF questionnaire including items such as time of first diagnosis, duration of last onset of symptoms, previous and current medications. Electrocardiographic criteria for AF were the absence of consistent P waves, presence of rapid irregular f waves with a frequency of 350-600 beats per minute, irregular ventricular response when atrioventricular (AV) conduction was intact. AF was classified into 4 temporal patterns based on the international consensus on nomenclature and classification on AF[21], and ACC/AHA/ESC 2006 guidelines for the management of patients with AF[22]. AF was classified as paroxysmal, persistent or permanent AF.

Statistical Analysis

Prevalence and 95% confidence intervals (95% CI) were calculated for 10 years old- and sex-specific groups. Sex-specific, age-standardized prevalence, sex-and age-standardized overall prevalence of AF were estimated by directly standardizing on the National Population Census of China in 2010. The total number of AF individuals aged ≥35 years in China were counted. The difference in prevalence of AF was assayed by χ^2 tests.

The association between prevalence of AF and its risk factors was analyzed by sex-specific and age-adjusted logistic regression analysis. Forward selection (entry criteria univariable *P*-value <0.10) stepwise multivariable-adjusted models were examined with age and sex forced in. Age was treated as a continuous variable with the odds ratio (*OR*) expressed per 10 years. Covariates eligible for entry included myocardial infarction, LVH, hypertension, diabetes, obesity, cigarette smoking, and alcohol consumption. Sex-modified effect was estimated by interaction analysis between sex and age and between sex and other factors with adjustment for age in the separate multivariable models. Post hoc power was calculated using a mini software from Mark Woodward[23]. All analyses were performed using the SAS software version 9.0. A two-tailed *P*-value <0.05 was considered statistically significant.

RESULTS

Prevalence of AF

Of the 19 363 individuals, 199 were diagnosed with AF. The AF was diagnosed according to the case history, current electrocardiogram and combined case history and current electrocardiogram accounted for 23.9%, 32.6%, and 43.5% respectively in males, and 33.6%, 28.0%, and 38.3% respectively in females (Table 1). Furthermore, the detection rate of AF with different methods was significantly different between urban and rural residents (*P*<0.001). The prevalence of AF detected according to case history was higher whereas that of AF detected according to electrocardiogram was lower in urban residents than in rural residents (44.9% *vs* 13.9%, 14.3% *vs* 45.5%). No significant difference on detection rate observed between males and females.

Table 1. AF Detected with Different Methods[*] (%)

Subgroup	Case History		ECG[#]		Case History & ECG		*P*
	N	%	*N*	%	*N*	%	
Men							
Urban	13	34.2	6	15.8	19	50	0.01
Rural	9	16.7	24	44.4	21	38.9	
Total	22	23.9	30	32.6	40	43.5	
Women							
Urban	31	51.7	8	13.3	21	35	<0.001
Rural	5	10.6	22	46.8	20	42.6	
Total	36	33.6	30	28.0	41	38.3	
Total							
Urban	44	44.9	14	14.3	40	40.8	<0.001
Rural	14	13.9	46	45.5	41	40.6	
Total	58	29.1	60	30.2	81	40.7	

Note. *P*-value *vs* constituent ratio between urban and rural residents. [*]Unadjusted percentages; [#]ECG performed during the survey.

The prevalence of AF was 1.03% in the population included in the present study. The age-adjusted prevalence of AF was 0.77% in males and 0.76% in females. The prevalence of AF was higher in elderly participants with their age ≥60 years than in younger participants with their age <60 years (1.83% *vs* 0.41% in males, 1.83% *vs* 0.43% in females, Table 2). The prevalence of AF was gradually elevated with advancing age groups (35-39, 40-49, 50-59, 60-69, ≥70 years old) in both men (0.29% to 3.43%) and women (0% to 2.73%) (Figure 2).

Prevalence Pattern of AF

Of the 199 individuals with AF, 19.0% of males and 30.9% of females were diagnosed with valve disease, 31.1% were first diagnosed with AF, 33.7% with paroxysmal AF, 7.4% with persistent AF, and 27.9% with permanent AF. No sex-difference was observed in AF patterns (P=0.70). The distribution of AF patterns was significantly different between urban and rural residents (P<0.001). The percentages of first diagnosed AF and paroxysmal AF varied in rural and urban residents (43.4% *vs.* 17.6%, and 20.2% *vs.* 48.4%, respectively), the percentages for persistent and permanent AF were similar in rural and urban residents.

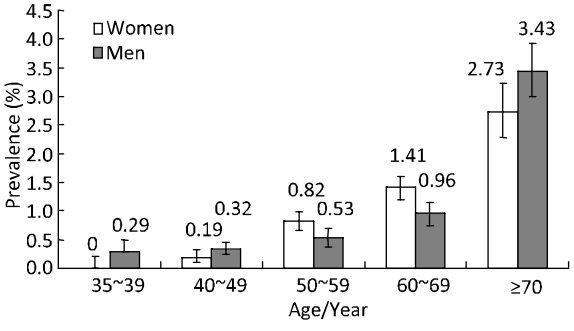

Figure 2. Prevalence of AF in different age and sex groups. Errors bars represent 95% CI.

Associated Factors for AF

Age-adjusted analyses showed that the odds of AF was significantly higher in patients with myocardial infarction and LVH than in those without myocardial infarction and LVH (P<0.05, Table 3) in both men and women. Females with obesity and smoking history were more likely to develop AF than those without obesity and smoking history (P<0.05). Males who drank alcohol were more likely to develop AF than those who did not drink alcohol (P=0.02).

Logistic regression analysis adjusted for the measured associated factors revealed that each advancing decade of age was associated with AF

Table 2. Prevalence of AF in Different Age Groups

Subgroup	Men			Women			Total		
	N	AF	%	*N*	AF	%	*N*	AF	%
Age<60									
Urban	1 786	8	0.45	2 093	14	0.67	3 879	22	0.57
Rural	2 856	11	0.39	4 258	13	0.31	7 114	24	0.34
Total	4 642	19	0.41	6 351	27	0.43	10 993	46	0.42
Age≥60									
Urban	1 713	30	1.75	1 965	46	2.34	3 678	76	2.07
Rural	2 280	43	1.89	2 412	34	1.41	4 692	77	1.64
Total	3 993	73	1.83	4 377	80	1.83	8 370	153	1.83
Total									
Urban	3 499	38	1.09	4 058	60	1.48	7 557	98	1.30
Rural	5 136	54	1.05	6 670	47	0.70	11 806	101	0.86
Total	8 635	92	1.07	10 728	107	1.00	19 363	199	1.03
Age adjusted Prevalence%* (95% CI)									
Urban		0.74 (0.46-1.00)			1.05 (0.75-1.39)			0.91 (0.70-1.12)	
Rural		0.79 (0.53-1.00)			0.57 (0.41-0.76)			0.67 (0.53-0.81)	
Total		0.78 (0.58-0.94)			0.76 (0.62-0.93)			0.77 (0.53-1.00)	

Note. *Standardized to the national population census of China in 2010.

Table 3. Prevalence of AF in Different Age Groups according to Selected Risk Factors

Variable		Men						Women					
		Unadjusted			Age-adjusted*			Unadjusted			Age-adjusted*		
		Number	AF, *n*	AF, %	OR	95% CI	*P*-value	Number	AF, *n*	AF, %	OR	95% CI	*P*-value
Older age (≥60 years)	Y	3993	73	1.8	-	-	-	4377	80	1.8	-	-	-
	N	4642	19	0.4				6351	27	0.4			
Myocardial infarction	Y	107	5	4.7	3.1	1.2-7.9	0.02	59	6	10.2	6.5	2.7-15.7	<0.01
	N	8528	87	1.0				10 669	101	0.9			
Left ventricular hypertrophy	Y	440	11	2.5	2.2	1.1-4.1	0.02	349	11	3.2	2	1.1-3.9	0.03
	N	8195	81	1.0				10379	96	0.9			
Hypertension	Y	3387	53	1.6	1.5	1.0-2.3	0.06	3931	55	1.4	1.1	0.7-1.6	0.68
	N	5248	39	0.7				6797	52	0.8			
Obesity	Y	959	15	1.6	1.7	1.0-3.0	0.05	1433	25	1.7	1.9	1.2-3.0	0.01
	N	7676	77	1.0				9295	82	0.9			
Diabetes	Y	630	10	1.6	1.4	0.7-2.7	0.35	802	13	1.6	1.3	0.7-2.3	0.44
	N	8005	82	1.0				9926	94	0.9			
Smoking	Y	5571	51	0.9	0.9	0.6-1.3	0.51	617	17	2.8	1.9	1.1-3.2	0.02
	N	3064	41	1.3				10 111	90	0.9			
Alcohol consumption	Y	4410	54	1.2	1.6	1.1-2.5	0.02	465	7	1.5	1.4	0.6-3.1	0.39
	N	4225	38	0.9				10 263	100	1			

Note. AF=atrial fibrillation; CI=confidence interval; N=no; OR=odds ratio; Y=yes. *Age as a continuous variable.

(OR=2.16, 95% CI: 1.88-2.48) and AF was not significantly associated with the sex (Table 4). LVH, obesity and alcohol consumption were significantly associated with AF (*P*≤0.02).

Table 4. Sex-pooled Stepwise Logistic Regression Analysis of Factors Associated with Prevalence of AF

Variable	OR	95% CI	*P*-value
Age (per 10 years)	2.16	1.88-2.48	<0.001
Female sex (y/n)	1.29	0.92-1.82	0.14
Myocardial infarction (y/n)	4.46	2.35-8.46	<0.001
Left ventricular hypertrophy (y/n)	2.22	1.41-3.51	<0.001
Obesity (y/n)	1.91	1.34-2.73	<0.001
Alcohol consumption (y/n)	1.57	1.09-2.27	0.02

Note. CI=confidence interval; OR=odds ratio; y=yes; *n*=no.

Multiple covariate-adjusted estimates of odds ratios for the associate factors with AF were similar between men and women, but was markedly different for smoking (OR=0.8, 95% CI: 0.5-1.2, *P*=0.220 in men) and (OR=1.6, 95% CI: 0.9-2.9, *P*=0.079 in women). (Electronic Supplement Table 1). Significant interaction occurred between sex and smoking (*P*=0.006). No significant interaction occurred between sex and other risk factors.

Post Hoc Power Calculation

In order to determine whether the previously reported risk factors are associated with AF in the multivariable sex-pooled models, post-hoc power analysis was performed to show the limited power in 199 AF events at an alpha of 0.05 for the detection of OR of 1.5 in hypertension with a power of 75.2% and diabetes with a power of 43.2%.

DISCUSSION

In the present study, the crude prevalence of AF was 0.42% and 1.83% respectively in participants aged 35-59 years and ≥60 years. The age-sex-adjusted prevalence of AF was 0.77% in individuals aged ≥35 years. The number of AF patients was calculated in Chinese population following the age- sex-adjusted prevalence in the current survey and the data from the National

Population Census in 2010[24]. Of the 686 034 561 inhabitants aged ≥35 years in China, 5.26 million suffered from AF (95% CI: 3.63-6.89).

The prevalence of AF was associated with advanced age, myocardial infarction, LVH, obesity, and alcohol consumption, which is consistent with that in Western populations.

Prevalence of Unrecognized AF

It was reported that the prevalence of unrecognized AF is about 12%[25], which is considerably lower than that (31%) in the present study, suggesting that the prevalence of unrecognized AF is relatively high in China, especially in rural areas.

Prevalence of AF

The reported prevalence of AF varies in different populations in the world. The prevalence of AF is 5.1% in ≥60 years old individuals of Netherland. 3.7% in ≥60 years old females and 5.4% in ≥60 years old males of United Kingdom, and 4.8% in ≥60 years old females and 6.2% in ≥60 years old males of USA[26].

The reported prevalence of AF is lower in some Asian populations (1.3% in ≥60 years old Hong Kong inhabitants, 2.1% in ≥60 years old Korean inhabitants[26-27], 0.7%-0.9% in ≥30 years old Japanese inhabitants[28]. Data from the present study are consistent with those from other previous Asian studies and from a published community-based study in China[15].

Most Western studies are longitudinal in design and AF is ascertained according to electrocardiogram, as well as data from hospitalization and outpatient medical records from follow-up. However, most Asian reports represent the prevalence of AF based on single occasional electrocardiography. Inhabitants in developing countries, particularly in rural areas, may have less access to medical care and routine medical checkup. There may be regional and ethnic variations in susceptibility of AF, which is similar to the reported variation of myocardial infarction. The incidence of myocardial infarction is higher in Western countries than in Asian countries. The prevalence of AF was lower in the present study than in European studies[29]. A meta-analysis[30] of seven prospective randomized controlled trials also showed a lower prevalence of AF in Asian populations than in Western populations. It was reported that genetic markers of European populations are associated with the increased risk of AF, which is consistent with the genetic racial variation[31]. Future longitudinal prospective studies directly comparing Western and Asian populations are therefore warranted.

Associated Factors for AF

The risk factors for AF have been reported in many prospective studies, but the vast majority of them are from Western countries. The prevalence of AF is associated with the advanced age as observed in the present study, which is consistent with the reported findings[25-26,32-34], indicating that some of the previously reported risk factors for AF in Western cohorts, such as myocardial infarction, LVH, obesity, and alcohol consumption[4,12-13,35-36], can also be identified in Chinese populations. The incidence of valvular AF in females and males in the present study is consistent with that in the Framingham heart study[34].

Advantages and Disadvantages

The advantages of our study are the good community-based survey design with participants from different regions, the routine ascertainment of AF, and the definition of cardiovascular disease risk factors, survey data, electrocardiogram and echocardiography, which are similar to other well-known community-based studies[12,26].

A number of limitations need to be acknowledged. The current study only gives the knowledge on epidemiology of AF in the population aged over 35 years since the limitation of age group. We may have underestimated the prevalence of AF due to use of questionnaires and electrocardiograms at one time point. The cross-sectional nature of our study may alter the distribution of risk factors for AF if the individuals with severe risk factors or cardiovascular disease did not survive or were less likely to be included in the survey. More over we had the limited ability to detect the association of AF with diabetes and hypertension. Our data need to be confirmed in prospective longitudinal studies in Asian samples. In addition, some important risk factors for AF well-defined in Western populations, such as heart failure, valvular heart disease, were not routinely ascertained in our study samples, which may therefore influence the exploration of the association between current risk factors and AF.

Finally, our extrapolations to the whole Chinese population based on data from the national population census in 2010 may not be definitive because they are based on a sample of only about

20 000 individuals and 199 AF cases. The prevalence of AF may also change during 2004-2010.

Clinical Implications

Although the age-specific prevalence of AF is lower in China than in Western countries, AF itself is an important public health problem in China. About 5.26 million inhabitants aged ≥35 years suffer from AF, higher than that in a previously study[15] and in USA[33].

In addition AF is unrecognized in many Chinese people. The opportunities for prevention of AF complications in China may be therefore substantial, given the availability of anticoagulant therapy, which can decrease the incidence of stroke, death[37], and the burden of unrecognized AF in China. Furthermore, the globle cardiovascular disease and its risk factors, and the population aging in China, suggest that the prevalence of AF will continue to increase in China. Since most reports on epidemiology of AF are only available from North America and Western Europe, it is critical to investigate the epidemiology of AF and its risk factors in non-Western and developing countries, especially in China for prevention of AF and its complications.

ACKNOWLEDGEMENTS

We highly appreciate colleagues at all levels for their participation and contributions in this study.

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Deyang Center for Disease Control and Prevention: WU Chen, WANG An Bing

Mudanjiang Medical Institute, Center for Disease Control and Prevention: LI Jian Min

Putuo Cardiovascular Institute, People's Hospital: LIU Cheng Guo, RUAN Lian Sheng

Disclosures: none.

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Electronic Supplement Table 1. Sex-specific Multivariable Logistic Regression Analysis of Variables in Males and Females

Variable	Men			Women		
	OR	95% CI	*P*	OR	95% CI	*P*
Age (10 ys)	2.2	1.8-2.7	<0.001	2.0	1.7-2.5	<0.001
MI (y/n)	3.0	1.2-7.7	0.023	5.9	2.4-14.7	<0.001
LVH (y/n)	2.2	1.1-4.2	0.021	2.3	1.2-4.4	0.014
HP (y/n)	1.3	0.8-2.0	0.290	0.9	0.6-1.4	0.626
Diabetes (y/n)	1.3	0.7-2.6	0.448	1.1	0.6-2.0	0.755
Obesity (y/n)	1.7	0.9-3.0	0.087	2.0	1.2-3.2	<0.010
Smoking (y/n)	0.8	0.5-1.2	0.220	1.6	0.9-2.9	0.079
Drinking (y/n)	1.8	1.2-2.8	0.010	1.3	0.6-2.9	0.526

Note. CI=confidence interval; OR=odds ratio; MI=Myocardial infarction; LVH=left ventricular hypertrophy; HP=Hypertension.