Circulation
JOURNAL OF THE AMERICAN HEART ASSOCIATION

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Circulation 2006;114;119-125; originally published online Jul 3, 2006;
DOI: 10.1161/CIRCULATIONAHA.105.595140
Circulation is published by the American Heart Association. 7272 Greenville Avenue, Dallas, TX 72514
 Print ISSN: 0009-7322. Online ISSN: 1524-4539

Secular Trends in Incidence of Atrial Fibrillation in Olmsted County, Minnesota, 1980 to 2000, and Implications on the Projections for Future Prevalence

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Background**—**Limited data exist on trends in incidence of atrial fibrillation (AF). We assessed the community-based trends in AF incidence for 1980 to 2000 and provided prevalence projections to 2050.

Methods and Results**—**The adult residents of Olmsted County, Minnesota, who had ECG-confirmed first AF in the period 1980 to 2000 (n=4618) were identified. Trends in age-adjusted incidence were determined and used to construct model-based prevalence estimates. The age- and sex-adjusted incidence of AF per 1000 person-years was 3.04 (95% CI, 2.78 to 3.31) in 1980 and 3.68 (95% CI, 3.42 to 3.95) in 2000. According to Poisson regression with adjustment for age and sex, incidence of AF increased significantly ($P=0.014$), with a relative increase of 12.6% (95% CI, 2.1 to 23.1) over 21 years. The increase in age-adjusted AF incidence did not differ between men and women ($P=0.84$). According to the US population projections by the US Census Bureau, the number of persons with AF is projected to be 12.1 million by 2050, assuming no further increase in age-adjusted incidence of AF, but 15.9 million if the increase in incidence continues.

Conclusions**—**The age-adjusted incidence of AF increased significantly in Olmsted County during 1980 to 2000. Whether or not this rate of increase continues, the projected number of persons with AF for the United States will exceed 10 million by 2050, underscoring the urgent need for primary prevention strategies against AF development. **(*Circulation*. 2006;114:119-125.)**

Key Words: atrium ■ fibrillation ■ epidemiology

Atrial fibrillation (AF) is a growing public health problem.[1] The number of persons with AF in the United States currently is estimated at 2.3 million and is projected to increase to 5.6 million by 2050.[2] AF is associated with increased risk of stroke,[3–5] heart failure,[6] cognitive dysfunction,[7,8] and premature death[9–12] and has enormous socioeconomic implications.[13,14]

Clinical Perspective p 125

The epidemiology of AF is changing. Reports from the Framingham investigators and our own group provide evidence that the age-adjusted prevalence of AF increased significantly during the 1960s through 1980s.[15,16] The reasons for these changing trends have not been fully elucidated. Among other factors, a true increase in the incidence could have contributed to the increase in prevalence, but the data on trends in AF incidence are sparse. In this study, we aimed to describe the trends in age-adjusted incidence of AF in a community in Olmsted County, Minnesota, over a 21-year period (1980 to 2000) and to provide an estimate of the prevalence of AF for the United States through 2050.

Methods

Study Setting

With approval from the Mayo Foundation Institutional Review Board, we conducted a community-based cohort study in Olmsted County. Olmsted County is relatively isolated from other urban centers, and medical care is delivered by only a few healthcare providers.[17] Most of the Olmsted County residents visit the Mayo Clinic regularly, allowing capturing of events.[17] For each patient, a unified medical record containing details of all inpatient and outpatient encounters is maintained. Within each medical record, diagnoses made from any of the encounters are coded and recorded in a central diagnostic index, which is searchable and retrievable.

Subjects and Data Collection

The medical records of Olmsted County adult residents who had first AF documented between January 1, 1980, and December 31, 2000, in any of the Mayo administrative databases (medical index, surgical index, ECG, and echocardiographic databases) were reviewed by one

Received October 13, 2005; revision received May 7, 2006; accepted May 12, 2006.

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The online-only Data Supplement Appendix can be found at http://circ.ahajournals.org/cgi/content/full/CIRCULATIONAHA.105.595140/DC1.

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Circulation is available at http://www.circulationaha.org

DOI: 10.1161/CIRCULATIONAHA.105.595140

cardiologist (Y.M.) and quality control of the data was provided by M.B. All diagnoses, covariates, and outcomes were defined a priori, and the same definitions were applied throughout the 21-year study period. Final inclusion in the study population required ECG confirmation of AF and verification that the AF episode was the first recognized AF event for the person. Patients with atrial flutter alone, without any evidence of AF, were not included. In this study, paroxysmal AF referred to AF that converted to sinus rhythm spontaneously or with treatment, with the predominant rhythm being sinus. Silent AF referred to asymptomatic AF that was identified incidentally. Definitions of medical conditions and other covariates are detailed in the online-only Data Supplement Appendix.

Statistical Analysis

Baseline characteristics were summarized by means and standard deviations or number and frequency percents stratified by calendar year of AF diagnosis. The significance of changes in any of the baseline variables by calendar year of AF diagnosis (regarded as a continuous variable) was assessed with linear regression analyses for continuous variables or logistic regression analyses for binary variables, after adjustment for age and sex. Only linear or linear logistic trends in calendar year of AF were considered.

Incidence

We estimated the age-, sex-, and calendar year–specific incidence rates of AF as follows. All identified cases were allocated to age-, sex-, and calendar-year–specific categories for the numerator. The Olmsted County population for the corresponding category was retrieved from the US Census Bureau Statistics, which served as the denominator. These age- and sex-specific incidence rates were used to calculate directly age-adjusted overall incidence rates for each sex- and each age- and sex-adjusted overall incidence rates using the 1990 sex and age distribution of the US white population. The 95% CIs were based on the Poisson distribution.

Trends in incidence over the 2 decades were assessed 2 ways. First, we used simple linear regression for the age-adjusted incidence rates (men, women, and overall) on calendar year. Second, using the SAS procedure GENMOD, the raw incidence data were modeled through the use of Poisson regression with a logarithmic link function and a log (population) offset term. A main effects model included a term for sex, a linear term for age, and a linear term for calendar year of AF diagnosis. All 2-way interactions and the 3-way interaction term were tested and incorporated as necessary. In particular, the presence of a calendar year effect was tested and CIs were estimated within the context of a main effects model, and the consistency of such an effect across age and sex categories was tested by the corresponding interactions of calendar year with age or sex.

Prevalence

A direct estimate of age-, sex-, and calendar year–specific prevalence would be prone to inaccuracies because of in- and out-migration. Instead, prevalence was estimated by "aging" a hypothetical cohort of 20 year olds to 99 years of age. Prevalence at each age was calculated recursively on the basis of prevalence at the previous age, the Poisson model–based probability of developing incident AF, and the probabilities of surviving the year for those with and without AF. The survival probabilities were based on Minnesota 1990 Life Tables and an exponential relative survival model for the AF incidence cohort. The recursive formulas used are shown in the online-only Data Supplement Appendix. These calculations were done using the incidence rates predicted for 1980 and, separately, those predicted for 2000. Finally, these 2 sets of age- and sex-specific prevalence estimates were averaged with respect to the same fixed age distribution (United States, 1990) to give overall age- and sex-adjusted prevalence in 1980 and 2000.

The prevalence of AF for 2050 was estimated from the US population projections as indicated by the US Census Bureau statistics and assuming the age-adjusted incidence we estimated for 2000 or a continued increase in incidence through 2050 at the rate evident for 1980 to 2000. For the first estimate, a CI was obtained by adding or subtracting 2 standard errors to each of the age-specific incidence rates estimated for 2000 and using these upper or lower incidence rate estimates in our recursive model. For the second estimate, no formal CI was deemed appropriate.

ECG Use

ECG use was estimated as the number of Olmsted County adult residents receiving at least 1 study in the calendar year divided by the Olmsted County adult population. All persons who ever had a prior ECG showing AF (prevalent cases) were excluded from analyses. The annual rate of increase in ECG use was estimated through linear regression and compared with the rate of increase in AF incidence. To assess whether an increase in ECG use could have accounted for the increase in AF incidence, we performed multiple linear regression of the age- and sex-adjusted AF incidence against calendar year and ECG use rate.

Obesity Trends in Olmsted County

To assess the possible impact of obesity trends on trends in AF incidence, we pooled 5 population-based samples of adults living in Rochester/Olmsted County: 3 bone density surveys (n=1678),[18–20] a survey on left ventricular diastolic function (n=2042),[21] and a subset (n=407) of control subjects for a diabetes incidence cohort,[22] with index dates spanning the time period 1980 to 2003 (n=4127). Age, sex, and measured height and weight were available for all subjects. Body mass index (BMI) was calculated, and an (ordinal) logistic model was fit to BMI categories (<20, 20 to 24.9, 25 to 29.9, 30 to 34.9, and ≥35 kg/m^2) with the explanatory variables of age, sex, and calendar year. Quadratic age and 2-way interaction terms were considered. The estimated age- and sex-specific probabilities from this model for 1980 and 2000 were used in conjunction with Olmsted County census data in 1990 to construct estimates of the hypothetical number of adult men and women whose BMI would have equaled or exceeded 30 kg/m^2 in 1980 and 2000 if the age distributions had been the same as in 1990. These numbers were divided by the total number of adults in 1990 to yield the age-adjusted prevalence of obesity in these 2 years. Finally, the impact of the increase in age-adjusted prevalence of obesity on age-adjusted AF incidence was estimated using a relative hazard[23] of 1.5 associated with BMI ≥30 kg/m^2 and compared with the observed value.

The authors had full access to the data and take full responsibility for their integrity. All authors have read and agree to the manuscript as written.

Results

A total of 6368 subjects ≥18 years of age were initially identified to have AF through the use of administrative databases. After review of the medical records, 876 patients were excluded because they had other types of atrial arrhythmias but not AF, and 874 were excluded because AF was first identified before January 1, 1980 (and therefore not incident cases). Thus, the study population consisted of the remaining 4618 subjects, whose mean age was 73±14 years (range, 18 to 107 years); 2365 (51%) were men. The baseline characteristics are displayed in Table 1.

Incidence and Time Trends of AF

Age- and sex-adjusted incidence per 1000 person-years was 3.04 (95% CI, 2.78 to 3.31) in 1980 and 3.68 (95% CI, 3.42 to 3.95) in 2000 based on linear regression applied to the yearly age-adjusted incidence rates of AF (P=0.008 for trend). The corresponding regression model–based sex-specific age-adjusted incidence rates per 1000 person-years were as follows: men, 4.09 (95% CI, 3.61 to 4.58) and 4.89 (95% CI, 4.40 to 5.38) in 1980 and 2000, respectively

TABLE 1. Baseline Characteristics of Incident AF Stratified by Calendar-Year of AF Diagnosis

		Calendar-Year of AF Diagnosis				
Variable	Overall (n=4618)	1980-1984 (n=826)	1985-1989 (n=938)	1990-1994 (n=1209)	1995-2000 (n=1645)	*P**
Age, y	73.1±14.4	72.9±14.5	72.8±14.1	73.0±14.7	73.4±14.3	0.07
<55	477 (10)	90 (11)	89 (9.5)	137 (11)	161 (9.8)	0.28
55-64	543 (12)	100 (12)	114 (12)	132 (11)	197 (12)	0.93
65-74	1118 (24)	187 (23)	260 (28)	294 (24)	377 (23)	0.23
75-84	1514 (33)	284 (34)	289 (31)	389 (32)	552 (34)	0.86
≥85	966 (21)	165 (20)	186 (20)	257 (21)	358 (22)	<0.05
Men	2365 (51)	412 (50)	469 (50)	629 (52)	855 (52)	0.08
BMI, kg/m^2	27.1±6.2	25.8±5.3	26.2±5.5	27.2±6.3	28.0±6.6	<0.0001
Systolic blood pressure, mm Hg	138±21	137±22	143±21	140±20	135±19	<0.0001
Diastolic blood pressure, mm Hg	78±11	78±11	80±10	79±11	75±11	<0.0001
Total cholesterol, mg/dL	200±49	212±56	207±52	199±47	192±45	<0.0001
Triglycerides, mg/dL	135±140	150±351	126±89	133±93	138±83	0.90
Paroxysmal AF	3428 (74)	590 (71)	701 (75)	891 (74)	1246 (76)	<0.01
Silent AF	1152 (25)	218 (26)	237 (25)	316 (26)	381 (23)	0.06
History of coronary artery disease	1776 (38)	315 (38)	400 (43)	441 (36)	620 (38)	0.15
Prior myocardial infarction	962 (21)	189 (23)	194 (21)	246 (20)	333 (20)	0.08
Concurrent myocardial infarction	166 (3.6)	29 (3.5)	34 (3.6)	47 (3.9)	56 (3.4)	0.64
Prior congestive heart failure	446 (9.7)	59 (7.1)	82 (8.7)	131 (11)	174 (11)	<0.01
Concurrent congestive heart failure	884 (19)	206 (25)	223 (24)	220 (18)	235 (14)	<0.0001
Valvular heart disease	1128 (24)	131 (16)	217 (23)	304 (25)	476 (29)	<0.0001
Coronary revascularization	575 (12)	44 (5.3)	83 (8.8)	154 (13)	294 (18)	<0.0001
History of cardiac surgery	535 (12)	63 (7.6)	92 (9.8)	139 (11)	241 (15)	<0.0001
Peripheral artery disease	605 (13)	105 (13)	139 (15)	161 (13)	200 (12)	0.16
Carotid artery disease	208 (4.5)	26 (3.1)	43 (4.6)	56 (4.6)	83 (5.0)	<0.05
History of stroke	437 (9.5)	86 (10)	85 (9.1)	128 (11)	138 (8.4)	0.09
Systemic hypertension	3694 (80)	580 (70)	754 (80)	982 (81)	1378 (84)	<0.0001
Diabetes mellitus	844 (18)	154 (19)	148 (16)	227 (19)	315 (19)	0.28
Dyslipidemia	1706 (37)	128 (15)	245 (26)	451 (37)	882 (54)	<0.0001
Current smoking	617 (13)	159 (19)	160 (17)	142 (12)	156 (9.5)	<0.0001
Regular alcohol use	539 (12)	89 (11)	119 (13)	151 (12)	180 (11)	0.79
Chronic obstructive pulmonary disease	1000 (22)	192 (23)	230 (25)	244 (20)	334 (20)	<0.05
Obstructive sleep apnea	90 (1.9)	0 (0)	4 (0.4)	15 (1.2)	71 (4.3)	<0.0001
Hyperthyroidism	47 (1.0)	10 (1.2)	18 (1.9)	8 (0.7)	11 (0.7)	<0.05
History of malignancy	1237 (27)	171 (21)	242 (26)	315 (26)	509 (31)	<0.0001
Angiotensin-converting enzyme inhibitor	504 (11)	5 (0.6)	27 (2.9)	157 (13)	315 (19)	<0.0001
Angiotensin receptor blocker	34 (0.7)	0 (0)	0 (0)	0 (0)	34 (2.1)	<0.0001
Calcium channel blocker	666 (14)	25 (3.0)	98 (10)	198 (16)	345 (21)	<0.0001
β-Blocker	687 (15)	89 (11)	115 (12)	147 (12)	336 (20)	<0.0001
Diuretic	1705 (37)	335 (41)	364 (39)	429 (35)	577 (35)	<0.01
Lipid-lowering therapy	222 (4.8)	2 (0.2)	6 (0.6)	30 (2.5)	184 (11)	<0.0001

Values are given as mean±SD or n (%).

**P* for trends across calendar-year of AF diagnosis by linear regression analysis for continuous variables and logistic regression analysis for binary variables, with adjustment for age and sex.

(P=0.061); women, 2.36 (95% CI, 2.14 to 2.58) and 2.80 (95% CI, 2.57 to 3.02) in 1980 and 2000, respectively (P=0.027) (Figure 1).

Poisson regression analyses showed that AF incidence was strongly related to age and male sex (both P<0.0001) (Table 2). The incidence ratio for men and women was 1.86 (P<0.01). According to Poisson regression with age and sex adjustment, the relative increase in incidence of AF in the overall cohort was 0.6% per year (95% CI, 0.1 to 1.1) or 12.6% for 21 years (95% CI, 2.1 to 23.1) (P=0.014). The

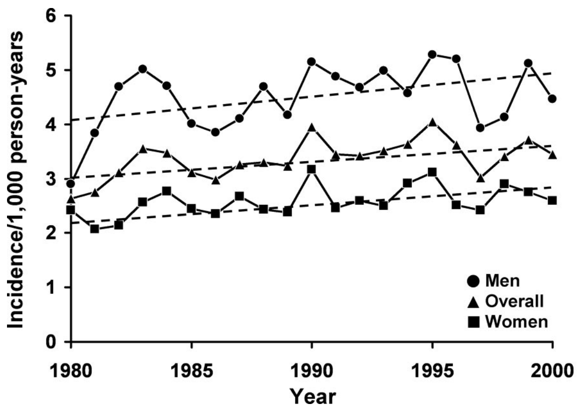

Figure 1. Overall and sex-specific trends in age-adjusted incidence of AF between 1980 and 2000 (age adjustment to the 1990 US population). Dotted line shows the linear regression model fit.

trend of increase reached significance (P=0.048) for men but not for women (P=0.138). However, the rate of increase in AF incidence was not significantly different between the sexes (P=0.84). There was a slight but statistically significant (P=0.0004) quantitative interaction between age and sex in the Poisson regression model for incidence, with men having a smaller age-related percent increase than women (The relative hazard for men versus women decreased from 2.09 [age, 55 years] to 1.71 [age, 85 years]; Table 2). However, this did not affect the analysis of time trends. There were no other significant interactions in the model.

Projection of AF Prevalence

On the basis of the Poisson estimates of increase in AF over the period 1980 to 2000 and the census data of the US population, a prevalence model (online-only Data Supplement Appendix) was developed for estimating age- and sex-specific prevalence rates and for projecting prevalence of AF in the United States assuming no change in relative survival over time. Applying our age- and sex-specific prevalence rates to US census data gave an estimated prevalence of AF in the United States of 2.1% (95% CI, 1.9 to 2.2) in 1980 (men, 2.3% [95% CI, 2.2 to 2.5]; women, 1.8% [95% CI, 1.7 to 1.9]) and 2.5% (95% CI, 2.4 to 2.7) in 2000 (men, 2.8% [95% CI, 2.7 to 3.0]; women, 2.3% [95% CI, 2.1 to 2.4]). Because of an increase in population size, this change in AF prevalence would imply an increase of 61% in the number of adults with AF from 3.2 million (95% CI, 2.9 to 3.4) in 1980 to 5.1 million (95% CI, 4.8 to 5.4) in 2000. The modeled prevalence rates of AF in 1990 are detailed in Table 3, which compared closely with the cross-sectional prevalence of AF in 2 Rochester/Olmsted County population-based studies.[24,25]

TABLE 3. Prevalence of AF by Model and by Survey Data From Rochester/Olmsted County, Minnesota

Age, y	Modeled Prevalence* 1990	Survey Prevalence† 1986[24]	1993-1995[25]
45-64	1.9	1.1	0.7
65-74	6.2	4.6	7.1
≥75	13.5	13.7	17.3
75-84	11.4	...	14.7
≥85	18.2	...	23.4

Values are percentages.

*Model-based age-specific prevalence in 1990.

†Prevalence data from a survey in a stratified random sample of the population of Rochester, Minn, in 1986[24] and the Stroke Prevention: Assessment of Risk in a Community (SPARC) in 1993-1995.[25]

TABLE 2. Incidence per 1000 Person-Years of AF Stratified by Calendar-Year of AF Diagnosis*

Gender and Age	Overall 1980-2000	1980-1984	1985-1989	1990-1994	1995-2000
Overall, age- and sex-adjusted incidence	3.40 (4618)	3.16 (826)	3.20 (938)	3.60 (1209)	3.52 (1645)
95% CI	3.30-3.50	2.94-3.38	2.99-3.40	3.40-3.81	3.35-3.70
Men, age-adjusted incidence	4.53 (2365)	4.26 (412)	4.17 (469)	4.84 (629)	4.67 (855)
95% CI	4.35-4.72	3.83-4.68	3.78-4.56	4.45-5.23	4.35-4.99
Age, y					
<55	0.62 (364)	0.53 (65)	0.53 (68)	0.76 (110)	0.64 (121)
55-64	4.34 (354)	4.28 (68)	4.00 (73)	4.39 (86)	4.56 (127)
65-74	12.91 (671)	10.24 (104)	14.33 (162)	13.68 (178)	12.93 (227)
75-84	24.52 (670)	25.52 (128)	19.80 (113)	25.05 (164)	26.31 (265)
≥85	39.66 (306)	36.35 (47)	32.96 (53)	46.81 (91)	40.06 (115)
Women, age-adjusted incidence	2.59 (2253)	2.40 (414)	2.46 (469)	2.72 (580)	2.71 (790)
95% CI	2.48-2.70	2.17-2.64	2.23-2.68	2.49-2.96	2.52-2.91
Age, y					
<55	0.19 (113)	0.20 (25)	0.16 (21)	0.18 (27)	0.21 (40)
55-64	2.16 (189)	1.75 (32)	2.10 (41)	2.24 (46)	2.37 (70)
65-74	6.79 (447)	5.91 (83)	6.50 (98)	7.23 (116)	7.28 (150)
75-84	17.14 (844)	15.75 (156)	16.15 (176)	18.45 (225)	17.69 (287)
≥85	27.69 (660)	27.92 (118)	25.76 (133)	27.79 (166)	28.67 (243)

*Data are presented as incidence rate per 1000 person-years followed in parentheses by actual number of cases observed.

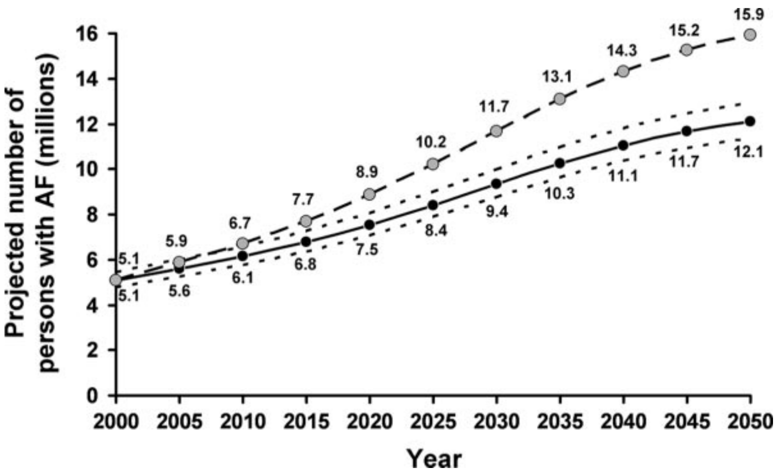

Figure 2. Projected number of persons with AF in the United States between 2000 and 2050, assuming no further increase in age-adjusted AF incidence (solid curve) and assuming a continued increase in incidence rate as evident in 1980 to 2000 (dotted curve).

If the same prevalence model were used, the projected number of adults with AF for the year 2050 would be 12.1 million (95% CI, 11.4 to 12.9) (2.4-fold increase from 2000), assuming no further increase in age-adjusted AF incidence beyond 2000. If we assume a continued increase in the incidence, then the projected number of adults with AF would be 15.9 million (3-fold increase from 2000) (Figure 2). Of the potential increase of 10.8 million persons with AF (5.1 in 2000 to 15.9 million in 2050), 3.8 million (35%) would be attributed to an increase in incidence and 7.0 million (65%) to increase in population size and shifting of the age distribution (2.4 million from population expansion and 4.6 million from increased longevity).

Trends in ECG Use

Linear regression of yearly rates from 1980 to 2000 against year showed a nonsignificant upward trend in ECG use ($P=0.10$). From this linear regression, the fitted proportion of Olmsted County residents who had an ECG performed was 17.4% in 1980, 18.2% in 1990, and 19.0% in 2000. The rate of increase in ECG use did not vary by sex. When age-adjusted AF incidence was regressed against both ECG use rate and calendar year of AF diagnosis, AF incidence was associated with calendar year of AF diagnosis ($P=0.022$) but not with ECG use rate ($P=0.58$). Additionally, an increase in the proportion of silent AF, discovered incidentally, would have been expected if the increase in AF incidence were secondary to an increase in ECG use. No such increasing trend was observed (Table 1). Taken together, ECG use could not account for the increase in AF incidence.

Obesity Trends and Estimated Impact on the Increase in AF Incidence

From a pooled analysis of 5 Rochester/Olmsted County population-based data sets (n=4127; mean age, 60±15 years; range, 21 to 97 years; 45% men), the estimated adjusted proportion of the adult population (adjusted to the Olmsted County 1990 population) whose BMI was ≥30 kg/m^2 increased from 10% to 25% during the study period of 1980 to 2000. In the Framingham study,[23] the relative hazard of incident AF was ≈1.5 for BMI ≥30 kg/m^2. Therefore, the 15% increase in the proportion of persons with obesity would be associated with an estimated 7.5% increase in AF incidence. Because our estimated percent increase in AF incidence was 12.6 (95% CI, 2.1 to 23.1), the estimated trend in obesity could account for ≈60% (95% CI, 32 to 100) of our estimated increase in age- and sex-adjusted AF incidence.

Discussion

The principal and new finding of this study was the significant increase in age-adjusted incidence of AF in Olmsted County over the period of 1980 to 2000. Assuming that the rate of increase in incidence remains unabated and assuming that these incidence rates can be applied to the entire US population, the projected number of persons with AF in the United States could reach 15.9 million by 2050.

Incidence and Time Trends of AF

Our study is unique in that it provides data on incidence of AF and trends from the recent years in a general population. Trends of AF incidence were available for very specific populations. For instance, there was a significant decline in the incidence of AF complicating myocardial infarction in 1990 to 1997[26]; yet in a different study, a 2-fold increase in the number of hospital patients diagnosed with AF or flutter in 1980 to 1999 was observed.[27]

The incidence rates from our study compare closely with those reported from the Framingham Heart Study[28] and Cardiovascular Health Study[29] (Figure 3) and with those reported from other countries, including Canada,[9] Scotland,[30] and the United Kingdom.[31] In this community-based study, the age- and sex-adjusted incidence in the overall cohort increased significantly, with a relative increase of 12.6% over 21 years. If this rate of increase continues, and with the changing demographics, we can project an increase in the number of persons with AF to 15.9 million by 2050.

Projected Burden of AF

The projection of AF burden was greater in our study than that by Go and colleagues.[2] Go et al provided estimates of 2.3 and 5.6 million adults with AF in the United States for years 2000 and 2050, respectively. Our study provided estimates of 5.1 million and 12.1 to 15.9 million for the years 2000 and 2050, respectively, which were 2.2- to 2.8-fold as high as those of Go et al. Several reasons for the discrepancy were possible. First, the study setting chosen was different. Go et al

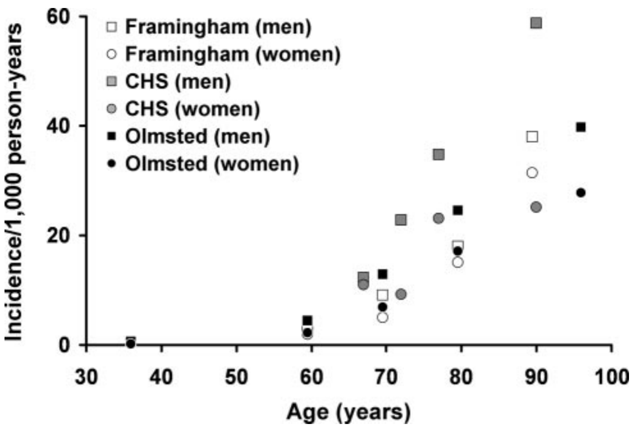

Figure 3. Incidence of AF per 1000 person-years stratified by age in the Framingham Heart Study,[28] the Cardiovascular Health Study (CHS),[29] and the present Olmsted County Study. The values plotted are the midpoints of the age ranges.

used a health maintenance organization in California[2]; we used an entire population in the Midwest. Second, there was a higher proportion of whites in our study population (96%[17]). Go et al reported an increased risk for white race, which would imply that the Olmsted County population should have a higher prevalence of AF. If we assume a relative risk of 1.3 for whites[2] and an overall proportion of whites in the United States of 80%, then the age-adjusted prevalence in Olmsted County should increase by 3.9% relative to the entire United States. Finally, probably the most important reason for the difference in the projections relates to a difference in case definition. In the study by Go et al,[2] attention was restricted to active AF during a specific time period, whereas in our study, a clinical history of AF with ECG confirmation was required. Our modeled prevalence estimates compared well with the prevalence of AF history from 2 Rochester/Olmsted County population-based studies,[24,25] thus supporting the validity of this model (Table 3). We suspect that even our projections represent conservative estimates, considering that we simply cannot determine the number of persons who have silent AF that was undetected. Using our prevalence model and US census data and projections to 2050, we estimated a potential increase in the number of AF cases by 3-fold over the next 50 years, with 35%, 43%, and 22% of the increase being attributable to an increase in incidence, aging of the population, and an increase in population size, respectively. To the extent that population projections and aging are known with some confidence, this implies that two thirds of this increase is more or less immutable but the remaining one third may be modifiable.

Possible Contributing Factors for the Increase in AF Incidence

The increase in incidence of AF over time was undoubtedly multifactorial. Systemic hypertension, diabetes mellitus, heart failure, myocardial infarction, and valvular heart disease all have been regarded as risk factors for AF.[28] Obesity as a risk factor has been controversial in the past, but the recent Framingham data convincingly suggested an important risk relationship between BMI and AF development.[23] Moreover, the prevalence of obesity in the adult US population increased over this time period.[32,33] On the basis of our pooled analysis of the Rochester/Olmsted County population-based data sets and assuming the relative risk of AF for obesity seen in the Framingham study,[23] the estimated change in obesity over the period of 1980 to 2000 (from 10% to 25%), age adjusted to the Olmsted 1990 population, could account for ≈60% of our estimated increase in age- and sex-adjusted AF incidence.

Study Limitations

The incidence of AF was undoubtedly underestimated, given that some patients were not seen at the Mayo Clinic, but the magnitude of underestimation would likely be small because the Mayo Clinic is the principal healthcare provider and referral center for Olmsted County.[17] Although the prevalence model was well supported by the actual prevalence data from 2 other Rochester/Olmsted County studies,[24,25] uncertainty remains with respect to the validity in extrapolating our data to the US population. Except for BMI, the definition and/or diagnosis of the various AF risk factors have changed over time. Thus, the time trends of prevalence of these risk factors and the extent of impact each had on the changing incidence could not be readily determined. Finally, we also acknowledge that the population of the Olmsted County is predominantly white, and whether similar incidence trends are also present in other ethnic and racial groups is unknown.

Conclusions

The community-based age-adjusted incidence of AF increased significantly during 1980 to 2000 in Olmsted County. In combination with the demographic changes expected for the United States, such an increase in age-adjusted incidence suggests a relatively conservative projection of a 3-fold increase in the number of persons with AF over the next 50 years. Aggressive intervention and primary prevention of reversible risk factors of AF are pivotal to contain this epidemic.

Source of Funding

Dr Miyasaka's research fellowship was funded by Kansai Medical University. Dr Tsang was supported by the American Heart Association Scientist Development Grant, National Institutes of Health RO1 grant AG 22070, and the American Society of Echocardiography Outcomes Research Grant.

Disclosures

None.

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CLINICAL PERSPECTIVE

Although atrial fibrillation has been qualitatively labeled an "epidemic," data on the actual magnitude of the current and anticipated burden of this public health problem are sparse. Prior studies have shown an increase in age-adjusted prevalence during the 1960s through 1980s, yet the contributing reasons remain far from clear. One potentially important factor is escalating incidence over time. In this 21-year study, we found a significant increase in age-adjusted incidence during the period of 1980 through 2000 in Olmsted County, Minnesota. This increase was not significantly different between men and women. Using the US Census Bureau data on population projections and our data with regard to the trends in incidence, we are projecting that the number of persons with atrial fibrillation in the United States in 2050 will exceed 10 million, whether or not the increase in age-adjusted incidence continues. These alarming findings underscore the critical need for primary prevention of atrial fibrillation and its risk factors.

Correction

In the version of the article "Secular Trends in Incidence of Atrial Fibrillation in Olmsted County, Minnesota, 1980 to 2000, and Implications on the Projections for Future Prevalence" by Miyasaka et al that published online before print on July 3, 2006, and appeared in the July 11, 2006, issue of the journal (*Circulation*. 2006;114:119–125), the "Sources of Funding" section stated that Dr Yoko Miyasaka was funded by Kansai Medical University. It should have stated that Dr Miyasaka's research fellowship was funded by Kansai Medical University.

Because of a miscommunication, this statement was temporarily removed from the online version. The corrected final statement is included in the current version.

DOI: 10.1161/CIRCULATIONAHA.106.178309

(*Circulation.* 2006;114:e498.)

***Circulation* is available at http://www.circulationaha.org**
DOI: 10.1161/CIRCULATIONAHA.106.178309