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Development of a Risk Score for Atrial Fibrillation in the Community; The Framingham Heart Study

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Abstract

Background—Atrial fibrillation (AF) contributes to substantial increases in morbidity and mortality. Our aim was to develop a risk prediction model to assess individuals' absolute risk for

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incident AF; to offer clinicians a tool to communicate risk; and to provide researchers a framework to evaluate new risk markers.

Methods—We examined 4764 Framingham Heart Study individuals (8044 person-exams; mean age 60.9 years, 55% women) aged 45–95 years. Multivariable Cox regression related clinical variables to 10-year AF incidence (n=457). Secondary analyses incorporated routine echocardiographic data (person-exams=7156, 445 events) for reclassifying individuals' AF risk.

Findings—Age, sex, significant murmur, heart failure, systolic blood pressure, hypertension treatment, body mass index, and electrocardiographic PR interval were associated with incident AF ($p<0.05$; clinical model C statistic=0.78, 95% confidence interval [CI] 0.76–0.80). Ten-year AF risk varied with age; >15% 10-year AF risk was observed in 1.0% of individuals <65 years versus 26.9% of participants ≥65 years. Predicted 10-year risk deciles for developing AF were similar to observed risks (calibration Chi-square statistic, 4.16, p=0.90). Additional incorporation of echocardiographic features minimally improved the C statistic from 0.78 (0.75, 0.80) to 0.79 (95% CI 0.77–0.82), p=0.005. Echocardiographic variables did not significantly improve net reclassification (p=0.18). We provide a point score for estimating AF risk with variables easily-measured in primary care.

Interpretation—The Framingham AF risk score may help risk stratify individuals in the community, and may provide a framework to evaluate new biological or genetic markers for AF risk prediction and help target individuals destined to develop AF for preventive measures.

Keywords

atrial fibrillation; risk score; epidemiology; echocardiography; cohort study

Atrial fibrillation (AF) is the most common sustained dysrhythmia, affecting more than 2 million individuals in the United States.[1;2] It is anticipated that the prevalence of AF will increase dramatically over the next few decades due to an aging population, improved cardiovascular therapies and longer survival with heart disease.[1;2] The onset of AF is associated with considerable increases in morbidity and mortality, even after adjusting for comorbid cardiovascular conditions.[3;4] The most life-threatening sequelae of AF are development of thromboembolic events and heart failure.[5;6] The identification of individuals at risk for incident AF in the community and the opportunity for prevention and early, targeted intervention might have a significant impact on health care costs.[7]

Findings from the Framingham Heart Study,[8–10] and other investigations,[11–13] have demonstrated that risk factors like advancing age, diabetes, hypertension, obesity, and cardiovascular disease, including alterations in cardiac structure and function,[9;13] consistently predispose to AF. However, to our knowledge, an instrument to evaluate an individual's absolute risk of AF integrating multiple risk factors is unavailable.

As evidenced by a recent National Heart Lung and Blood Institute Workshop (http://www.nhlbi.nih.gov/meetings/workshops/prevent-af.htm) there is increasing scientific interest in developing strategies to prevent AF. Critical for efforts to prevent AF is having a thorough understanding of the factors that predispose to its onset. Establishing a risk score accounting for standard clinical characteristics will be instrumental for evaluating the numerous efforts to introduce 'novel' technologies, biomarkers, and genetic data to improve AF risk prediction. In addition, an AF risk score will be requisite to identifying individuals at highest risk for AF, to target enrollment in future AF primary prevention trials. We formulated a risk algorithm for incident AF, hypothesizing that AF is well predicted by a score, comprising weighted clinical characteristics that can be assessed in a primary care setting.

MATERIALS AND METHODS

Study Sample

Eligible participants were free of AF, were between ages 45 and 95 years, and attended Framingham Heart Study Original cohort[14] examination cycle 11 (1968–1971, n=2955) or examination cycle 17 (1981–1984, n=2179), or Offspring[15] examination 1 (1971–1975, n=5124) or examination 3 (1984–1987, n=3873). Participants were followed for up to 10 years for incident AF till fall 2007. Study protocols were approved by Boston University Medical Center Institutional Review Board, and participants signed consent. See Supplement for further details on study samples.

Clinical Evaluations (See Supplement for details)

AF was diagnosed according to current guidelines[16] if atrial flutter or atrial fibrillation was present on electrocardiogram obtained from Framingham Heart Study clinic visit, outside physician or hospital charts, or Holter reports. Heart failure was diagnosed based on major and minor clinical criteria (for details see the Supplement).[17] A significant cardiac murmur was considered present if grade ≥3 out of 6 systolic or any diastolic murmur was auscultated by the Framingham clinic physician. Cardiovascular events are regularly adjudicated by a committee of three Framingham investigators. Framingham Study physician measurement of systolic blood pressure ≥140 or diastolic blood pressure ≥90 mm Hg or antihypertensive treatment resulted in the diagnosis of hypertension.

Echocardiography

Routinely acquired, standardized two-dimensionally guided M-mode echocardiograms were available from a different sample comprising Cohort examination 16 (n=2177; 1979–1981) and Offspring examinations 2 (n=1864; 1979–1983) and 5 (n=3115; 1991–1995). Based on prior reports we selected left atrial diameter, sum of diastolic interventricular septal and posterolateral wall thicknesses and left ventricular fractional shortening (systolic function measure),[18] to test whether echocardiographic measurements improved AF risk prediction over the clinical model.

Statistical Analysis

Sex-pooled multivariable Cox regression models were used to assess risk factors for incidence of initial AF event over 10 years; follow-up was censored after 10 years. Time dependent individual risk factors and the set of final model risk factors (p=0.28) were not statistically significant, supporting the proportionality of hazards assumption. We used cross-sectional pooling[19] to construct the data set for analysis with participants becoming eligible to reenter analyses after a 12-year event-free survival. Selection of eligible risk factors was based on prior reports,[8] and included calendar decade, systolic blood pressure, antihypertensive medication, height, body mass index, current cigarette smoking, diabetes mellitus, significant murmur, electrocardiographic features (left ventricular hypertrophy, PR interval, and heart rate), total cholesterol, alcohol consumption, history of myocardial infarction, heart failure, and cardiovascular disease. Age and sex were forced into models. Interactions among risk factors that were biologically plausible were examined and retained if they improved model discrimination and calibration. A risk scoring system for outcome was developed based on Cox models.[20]

Model discrimination was estimated by C statistic, and calibration was assessed by agreement between predicted and observed 10-year event rates in deciles of predicted risk.[21] Natural logarithmic continuous risk factors were examined, but did not improve model discrimination or calibration. We ran an internal validation of the discrimination (C statistic) and calibration

(modified Hosmer-Lemeshow statistic for survival analysis) using bootstrapping with 1000 replications of individuals sampled with replacement. We further assessed whether the incorporation of echocardiographic data might lead to reclassification of individuals in predefined AF risk groups (<5%, 5–15%, >15%).[22] All analyses were performed using SAS version 9.1 (SAS Institute: Cary, North Carolina).

Secondary Analyses (see Supplement)

Pre-specified secondary analyses were performed to assess model fit and calibration in subgroups by sex and age (<65 versus ≥65 years). In addition, we examined if echocardiographic measures improved AF risk prediction in the later examination, and in participant subsets.

RESULTS

Participant Characteristics

Baseline characteristics for the overall study cohort (8044 observations on 4764 participants) are presented in Table 1 (sex-specific characteristics Supplementary Table 1). Briefly, the mean age was 60.9 (range, 45 to 95) years and 55% were women. Fewer than 5% of individuals had baseline electrocardiographic left ventricular hypertrophy, significant murmur, heart failure or myocardial infarction. Over the 10-year follow-up period, 457 participants developed AF. There were 253 events in men over 32,544 person-years of follow-up (6.3 per 1000 age-adjusted person-years) and 204 events in women over 41,717 years of follow-up (3.3 per 1000 age-adjusted person-years).

Risk Models

In age- and sex-adjusted Cox models (Table 2) several factors were associated with incident AF including demographics (advancing age, sex), body mass index, blood pressure (systolic, pulse pressure, and treatment), electrocardiographic features (left ventricular hypertrophy and PR interval), and prevalent heart disease (significant murmur, heart failure and myocardial infarction).

The age-adjusted sex-specific risk factors for AF are presented in Supplementary Table 2. In exploratory models we did not observe sex-interactions in age-adjusted risk for incident AF that met the 0.01 level of significance chosen to account for multiple testing.

Variables that were associated with AF at $p<0.05$ level in age- and sex-adjusted Cox regression analysis were eligible for the final multivariable model. If highly collinear variables both reached the significance level, we selected the more clinically available measure. The following factors were significant at the 0.05 level in multivariable models and entered the prediction score: significant murmur, heart failure, systolic blood pressure, hypertension treatment, body mass index and PR interval. Observed interactions of sex, significant murmur, and heart failure by age, were accommodated by adding interaction terms. For final model Cox proportional hazards regression coefficients see Supplementary Table 3. The final model revealed a C statistic of 0.78 (95% confidence interval [CI] 0.76–0.80) as a measure of discrimination. The mean (SD) of the bootstrap validated C statistic was 0.76 (0.08) and the mean (SD) of the calibration chi-square statistic was 10.9 (5.1).

Based on the final model, a point score sheet was developed (Figure 1). An individual's scores may be summed to produce a total point score that corresponds to a specific 10-year absolute risk of AF available at http://www.framinghamheartstudy.org/risk/index.html.[a] The risk derived from the point score may slightly deviate from the more accurate continuous equation risk calculator; the deviation is evident at the extremes of the risk factor distribution.

Figure 2 exemplifies the relation of selected risk factors to predicted risk of AF based on the risk equation (Supplementary Figure 1 shows the same results for the point score). We have included a risk prediction scheme without PR interval in the electronic supplement for settings that do not perform electrocardiograms routinely. The distribution of individuals according to predicted 10-year risk of AF is provided in Supplementary Table 4.

Secondary analyses

In secondary analyses we observed that the model fit and calibration was consistent in men and women and in younger versus older participants (Supplement and Supplementary Figures 2 & 3). The developed risk score was applied to a later Framingham Study data set (n=7156) including baseline variables from Cohort examination 16 and Offspring examinations 2 and 5 with 445 AF events. Recalibration was achieved by adjustment for the baseline survival at 10 years S_0 (10)=0.956 in this sample. The C statistic was 0.76 (95% CI 0.74–0.79) and we observed good calibration for deciles of predicted risk (Chi-square statistic 10.47).

All three echocardiographic measures were associated with AF incidence (Supplementary Table 5). Additional incorporation of echocardiographic variables simultaneously in the model improved the C statistic calculated for this sample from 0.78 (0.75–0.80) to 0.79 (95% CI 0.77–0.82), p=0.005. We evaluated risk reclassification with two recently described test statistics, integrated discrimination and net reclassification improvement.[22] Integrated discrimination does not rely on specific cutoffs for reclassification, instead evaluating reclassification as a continuous outcome across the spectrum of risk; a value of zero would mean no movement in predicted risk. With the inclusion of echocardiographic variables we observed a small positive shift in integrated discrimination improvement (0.02, 95% CI 0.009–0.03, p=0.0003). A more clinically intuitive method of evaluating risk is net reclassification, which is based on prespecified risk categories. The net reclassification improvement based on 10-year AF risk categories (<5%, 5–15%, >15%) was modest and not statistically significant (0.04 95% CI −0.02–0.10, p=0.18); 331 participants who did not develop AF were upwardly classified and 312 were downwardly classified with the addition of echocardiographic variables. Among those who developed AF, 39 were upwardly classified and 27 were downwardly classified. But, overall, few participants had clinically meaningful changes in risk category (i.e. shifting between low, intermediate, or high risk) with the addition of echocardiographic variables (Table 3). The performance of the risk score with the addition of echocardiographic variables in clinical subgroups is provided in Supplementary Table 6. Of the 18 subgroups we examined (classified by age, hypertension, structural heart disease, and AF risk status), the only subgroup with a suggestion of improved performance with echocardiography was individuals with valvular heart disease or heart failure (p=0.03).

DISCUSSION

Principal Findings

In a community-based cohort we present a risk prediction scheme that predicts an individual's absolute risk of developing AF in the subsequent decade based on clinical factors that can be assessed readily in primary care. The risk score reasonably accurately stratifies individuals into risk categories. The score incorporates known, clinically available risk factors in relation to initial AF; the score is minimally improved by the addition of standard echocardiographic variables in secondary analyses. A robust risk prediction scheme is necessary to evaluate the incremental utility of rapidly emerging novel risk factors for AF, including subclinical disease, laboratory, proteomic and genomic markers.

[a]Please see supplemental files for the excel tool that will be publically downloadable from the Framingham website (risk score profiles tab) upon publication.

Heretofore AF prevention received little attention, which prompted a recent National Heart Lung and Blood Institute Conference to identify knowledge deficits and research strategies to promote AF prevention. Capturing absolute risk of AF as provided by this new instrument, is one step to assess patient utilities, cost-effectiveness and refine decisions to pursue preventive therapies. A risk prediction tool may build a framework for targeting individuals for AF prevention both clinically and for potential AF prevention trials.

Similar to myocardial infarction and heart failure, the prevention or postponement of AF may be clinically achievable in the future. There are meta-analyses supporting the protective effect of statins and angiotensin-converting enzyme inhibitors regarding AF onset.[23;24] In persons with valve disease or heart failure who are at high risk of developing AF, this multivariable risk assessment for AF may identify persons who might benefit from periodic ECG monitoring for AF and aggressive control of correctable predisposing factors. The explosion of biological and genetic markers will increase insights into the pathogenesis of AF and will provide opportunities for the development of preventive therapies.

AF risk factors and reclassification

Our results confirmed prior knowledge regarding individual risk factors for incident AF such as age and sex, as well as body mass index, blood pressure variables, and prevalent cardiovascular disease.[8;10;12;25] The developed risk prediction model comprising the strongest risk factors performed similarly in younger and older individuals. Valvular heart disease and heart failure were dominant factors in the risk estimation of younger individuals whereas, with increasing age, they were less strongly associated with AF risk. The known lower risk of AF in women compared to males was accounted for in the point score scheme by a slower accumulation of risk points with advancing age.

PR interval has been less appreciated as an AF risk factor. Prior studies have shown that P-wave characteristics are associated with AF.[26–28] We have demonstrated in a community-based sample, that PR interval measured from the surface ECG may be a valuable additional risk indicator for long-term AF occurrence. Whether conductance impairment is a causal factor for AF has to be further investigated.

Because of growing dissatisfaction with discrimination (C statistics) to judge the utility of novel predictive factors, reclassification metrics are being actively investigated.[22] Secondary analyses including echocardiographic data reflecting left ventricular hypertrophy, atrial diameter and left ventricular systolic function did lead to additional refinement in the predictive power of the risk score. Although, the integrated reclassification of risk as a continuous measure was statistically significant, net reclassification, represented by the number of people who meaningfully changed risk categories by the addition of echocardiographic features was clinically modest and not statistically significant. Given costs, it is unlikely that routine echocardiography to predict AF risk would be justifiable for AF primary prevention screening in the general population in the present era. However, secondary analyses suggested that echocardiography may be valuable for reclassifying AF risk in individuals with valvular heart disease or heart failure.

Strengths and Limitations

The community-based nature of the cohort, routinely ascertained clinical variables, rigorous adjudication of AF events, and novelty of a risk score combining established risk factors to predict incident AF are strengths of the study. For internal replication we demonstrated that the risk prediction models worked equivalently well at different baseline examinations and had good performance in both sexes and in middle-aged and older adults. However, there was overlap in individuals between the earlier and later Framingham datasets.

The proposed risk score has been developed and validated in a white, middle-aged to elderly cohort. We note that the scheme may not be generalizable to younger individuals as we had too few young adults with AF. Additionally, it is well known that the incidence of AF differs in other ethnicities.[29] Whereas other cardiovascular risk scores developed in Framingham perform well in independent cohorts,[30] we acknowledge that our AF risk score must be validated, and potentially recalibrated in other ethnicities/races. Similarly, secular trends, with increasing incidence in AF over time has been reported.[2] If the risk factors or incidence of AF change over time, the risk function may need to be recalibrated. We acknowledge that data were prospectively collected, but retrospectively analyzed. Critically, the external validity of the risk function has to be proven prospectively in independent samples.

The epidemiological nature of the study, which employs standard clinical tests, contributes to some limitations. We purposefully examined clinical factors which are readily and routinely ascertained in general clinical practice. We acknowledge that other factors may be incorporated in risk models targeted to specific patient subsets. For instance, in the elderly, thyroid status may improve the risk score.[31] In addition, physical activity level may represent an easily assessable risk factor that merits investigation in future studies.[32;33]

The present risk assessment relies on blood pressure measurements during a single clinic visit which may lead to misclassification. Future studies should examine whether repeated blood pressure measures increase the accuracy of the risk score. Analogously, despite routine follow-up and rigorous verification of cases, we may have overlooked asymptomatic forms of AF detectable by more sophisticated monitoring. The misclassification of AF status may have reduced the accuracy of the risk prediction score.

With regards to our echocardiographic analyses, we acknowledge that experts may disagree as to what constitutes clinically significant levels of reclassification. Furthermore, to have sufficient follow-up, we relied on M-Mode technology; more sophisticated echocardiographic measures may improve risk prediction. Whether there are selected subsets of individuals for whom echocardiographic screening would be justified, requires further examination.

If our AF risk score is validated our findings will provide the sound basis for future studies that investigate whether the early detection of an increased risk of AF will help prevent AF cases. The prevention of AF is of paramount importance because of the aging of the population, temporal trends indicating that there may be as many as 15.9 million AF patients in the United States in the year 2050 and similar projections of an increase in prevalence in the western world.[2] In addition, the life-threatening sequelae of AF and the substantial morbidity and mortality associated with its treatment provide the motivation to research its prevention. Reliable risk prediction also is critical to advance research efforts to develop novel risk markers and target high risk individuals for future prevention trials. Whereas the lifetime risk of AF is about one out of four individuals,[34] the current risk score provides the clinician with an easily applicable tool that may improve individual risk assessment, communication and targeting of interventions in daily clinical practice if replicated in independent studies.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Emelia J. Benjamin and all co-authors had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. Emelia J. Benjamin had final responsibility for the decision to submit for publication

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Abbreviations

AF
atrial fibrillation

CI
confidence interval

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Age, years	Points for Women	Points for Men	
45-49	-3	1	
50-54	-2	2	
55-59	0	3	
60-64	1	4	
65-69	3	5	
70-74	4	6	
75-79	6	7	
80-84	7	7	
≥85	8	8	Points=

Systolic Blood Pressure, mm Hg	Points	
<160	0	
≥160	1	Points=

Hypertension Treatment		
No	0	
Yes	1	Points=

Body Mass Index, kg/m^2		
<30	0	
≥30	1	Points=

PR Interval, milliseconds		
<160	0	
160-190	1	
≥200	2	Points=

Significant Murmur by Years of Age		
45-54	5	
55-64	4	
65-74	2	
75-84	1	
≥85	0	Points=

Heart Failure by Years of Age		
45-54	10	
55-64	6	
65-74	2	
≥75-84	0	Points=
		TOTAL Points=

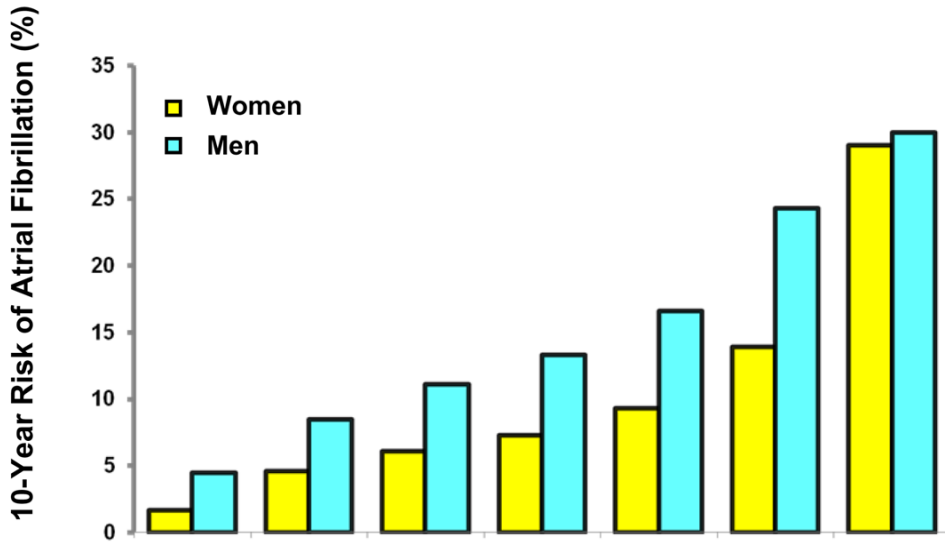
TOTAL Points and Risk Estimates

Total Points	≤ 0	1	2	3	4	5	6	7	8	9	≥10
Risk, %	≤1	2	2	3	4	6	8	12	16	22	>30

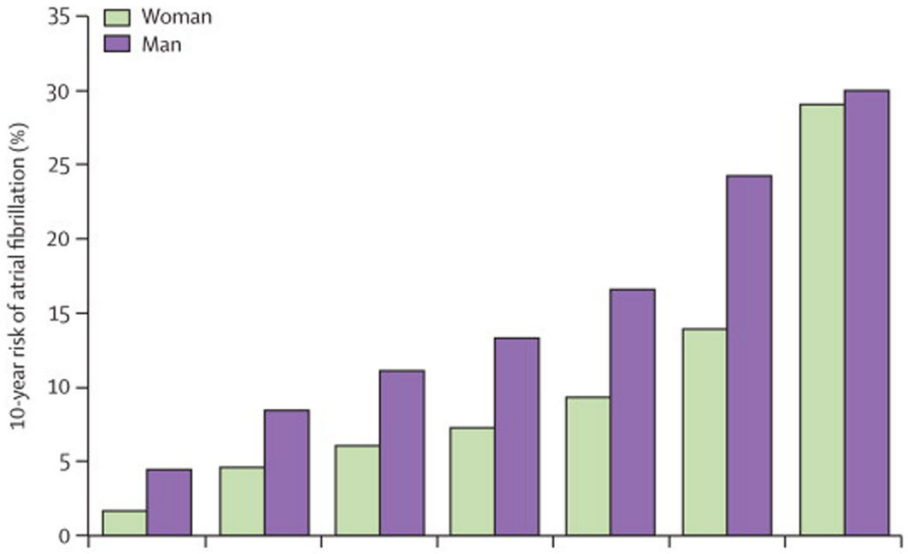
Figure 1. Predicted 10-Year Risk of Atrial Fibrillation

Point Scores Based on Framingham Participants Aged 45 to 95 Years.

The point scores provided are approximations for results from continuous risk functions; categories assigned 0 points should not be misconstrued to imply the presence of biological threshold effects. The exact equations are given in the supplement and on our website (http://www.framinghamheartstudy.org/risk/index.html). The scores derived from the point scheme may slightly differ from the equation-based results in cases with rare combinations of risk factors.



Risk Factors							
Age, years	60	70	70	70	70	70	70
PR interval, msec	160	160	200	200	200	200	200
Body mass index, kg/m	25	25	25	35	35	35	35
Systolic BP, mm Hg	120	120	120	120	160	160	160
Hypertension treatment	no	no	no	no	no	yes	yes
Heart failure or murmur	no	no	no	no	no	no	yes



Age (years)	60	70	70	70	70	70	70
PR interval (ms)	160	160	200	200	200	200	200
Body-mass index (kg/m^2)	25	25	25	35	35	35	35
Systolic BP (mm Hg)	120	120	120	120	160	160	160
Hypertension treatment	No	No	No	No	No	Yes	Yes
Heart failure or murmur	No	No	No	No	No	No	Yes

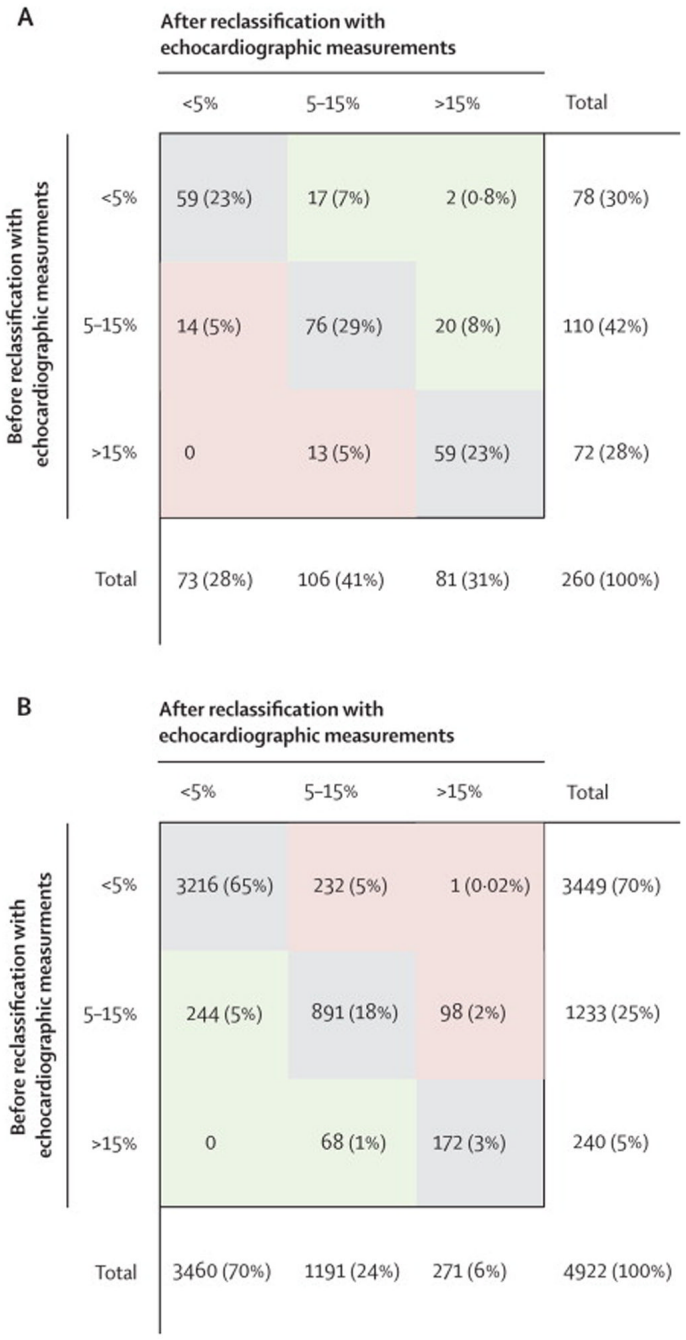


Figure 2. Relation of Selected Risk Factors to the Predicted (AF Risk Function) 10-Year Risks of Incident AF by Sex at Specified Risk Factor Levels Based on the Risk Equation

A similar figure based on the point scores is available in Figure 1 of the Supplement.

Table 1

Baseline Characteristics of the Sample*

Clinical Characteristics	**Total Sample (person-exams=8044)**
Age, y	60.9 (9.9)
Women, No, (%)	4453 (55)
Current smoking, No. (%)	2563 (32)
Alcohol consumption, drinks per week	7.0 (10.5)
Moderate to heavy alcohol consumption, No. (%)	1749 (22)
Body mass index, kg/m^2	26.3 (4.3)
Height, m	1.7 (0.1)
Systolic pressure, mm Hg	136 (21)
Diastolic pressure, mm Hg	81 (11)
Pulse pressure, mm Hg	55 (17)
Heart rate, beats per minute	72 (13)
Total cholesterol, mg/dL/mmol/L	229 (42)/5.9 (1.1)
HDL cholesterol, mg/dL/mmol/L	52 (16)/51.5 (15.8)
Total/high density lipoprotein cholesterol	4.8 (1.7)
Triglycerides, mg/dL/mmol/L	303 (281)/3.4 (3.2)
Diabetes, No. (%)	1124 (14)
Hypertension treatment, No. (%)	1941 (24)
Electrocardiographic left ventricular hypertrophy, No. (%)	182 (3)
Electrocardiographic PR-interval, msec	164 (23)
Significant murmur, No. (%)	226 (3)
Prevalent heart failure, No. (%)	70 (1)
Prevalent myocardial infarction, No. (%)	321 (4)

* Values are mean (SD) except as noted.

One drink of alcohol on average equals 12g alcohol.

Table 2

Age- and Sex-adjusted Cox Proportional Hazards Models for Predictors of Incident Atrial Fibrillation

Variable	Hazards Ratio†	95% Confidence Interval		*P* Value
Age, years	2.28	2.08	2.49	0.0001
Men (versus women)*	1.90	1.58	2.29	0.0001
Current smoking	1.08	0.88	1.33	0.47
Alcohol consumption (number of drinks)	1.01	1.00	1.01	0.26
Moderate to heavy drinking	1.05	0.83	1.32	0.71
Body mass index	1.19	1.08	1.30	0.0002
Height	1.14	1.00	1.30	0.055
Systolic blood pressure	1.21	1.11	1.33	0.0001
Diastolic blood pressure	1.04	0.95	1.14	0.44
Pulse pressure	1.25	1.14	1.36	0.0001
Heart rate	0.98	0.89	1.08	0.71
Total cholesterol	0.95	0.86	1.05	0.32
HDL cholesterol	0.98	0.88	1.09	0.75
Triglycerides	1.02	0.89	1.16	0.79
Diabetes	1.10	0.87	1.38	0.43
Hypertension treatment	1.80	1.48	2.18	0.0001
Electrocardiographic left ventricular hypertrophy	1.36	1.03	1.80	0.03
Electrocardiographic PR interval	1.23	1.14	1.32	0.0001
Significant murmur	2.38	1.71	3.32	0.0001
Prevalent heart failure	3.20	1.99	5.16	0.0001
Prevalent myocardial infarction	1.44	1.02	2.03	0.04

*Sex-adjusted for age.

†Hazard ratios are expressed per 1 standard deviation increase for continuous variables (see Table 1) and for the condition present in dichotomous variables.

One drink of alcohol on average equals 12g alcohol.

Table 3

Reclassification Based on Whether the Individual Does or Does not Develop Atrial Fibrillation in 10 Years.

Without echocardiographic variables	With echocardiographic variables			
	<5%	**5–15%**	**>15%**	**Total**
Participants who do not develop atrial fibrillation				
<5%	3216 (65.3)	232 (4.7)	1 (0.02)	3449 (70.1)
5–15%	244 (5.0)	891 (18.1)	98 (2.0)	1233 (25.1)
>15%	0 (0.0)	68 (1.4)	172 (3.5)	240 (4.9)
Total	3460 (70.3)	1191 (24.2)	271 (5.5)	4922 (100.0)
Participants who developed atrial fibrillation				
<5%	59 (22.7)	17 (6.5)	2 (0.8)	78 (30.0)
5–15%	14 (5.4)	76 (29.2)	20 (7.7)	110 (42.3)
>15%	0 (0.0)	13 (5)	59 (22.7)	72 (27.7)
Total	73 (28.1)	106 (40.8)	81 (31.2)	260 (100.0)

Individuals in the shaded diagonal boxes did not change classification with echocardiography; those above the diagonal had improved reclassification with echocardiography; those below the diagonal echocardiography worsened reclassification.

The net reclassification improvement was 0.04 (95% CI −0.02–0.10, p=0.18). Among individuals who did not develop AF in 10 years follow-up, echocardiographic variables up-classified 331 and down-classified 312 individuals. Among those participants who developed AF, 39 were up-classified and 27 were down-classified with echocardiography.