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ORIGINAL RESEARCH

Thirty-Year Trends in the Incidence of Atrial Fibrillation: The ARIC Study

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BACKGROUND: Long-term data to study recent trends in the incidence of atrial fibrillation (AF), overall and among sex and race groups, are scarce. We evaluated the 30-year trends in the incidence of AF in the ARIC (Atherosclerosis Risk in Communities) study cohort and explored race and sex differences in these trends.

METHODS AND RESULTS: We included 15 343 men and women aged 45 to 64 years in 1987 to 1989 without AF from 4 US communities in the ARIC cohort. Incident AF was identified based on study ECGs, hospital discharge codes, and death certificates through 2017. We calculated age and period-specific incidence rates (IRs) of AF. We used Poisson regression to calculate IR ratios of AF over time adjusting for age, sex, and race. A total of 3241 AF cases were identified during a mean (SD) follow-up of 22 years (8.4 years) (599 in Black participants, 2642 in White participants, 1582 in women, and 1659 in men). Overall, the IR of AF in the ARIC cohort was 9.6 per 1000 person-years (6.9 in Black participants, 10.5 in White participants, 8.1 in women, and 11.6 in men). Age-specific IR by time period did not show significant changes over time. In a model adjusted for sex, race, and age group, the rate of AF did not change significantly from 1987 to 1991 compared with 2012 to 2017 (IR ratio, 1.10 [95% CI, 0.88–1.36] comparing 2012–2017 with 1987–1991). Similarly, no evidence of changes over time in AF rates were identified in men and women or White and Black participants separately.

CONCLUSIONS: Even though IRs of AF increase as age increases, our analysis provided evidence suggesting that the overall IRs of AF have not changed over time in a multicenter cohort of Black and White individuals in the United States from 1987 to 2017.

Key Words: atrial fibrillation ■ epidemiology ■ incidence ■ trends

Atrial fibrillation (AF) is one of the most common clinically relevant cardiac arrythmias, characterized by abnormal electrical activity of the heart that causes the atria to fibrillate. Globally, the burden of AF has increased over time and varies regionally with low-middle–income countries experiencing lower prevalence compared with high-income countries.[1] The Global Burden of Disease 2010 study estimated that there are 33.5 million (20.9 million men [95% uncertainty interval, 19.5–22.2 million] and 12.6 million women [95% uncertainty interval, 12.0–13.7 million]) individuals globally with prevalent AF.[2,3]

Studies in the United States have reported inconsistent results. FHS (Framingham Heart Study) (1958 to 2007) and a study in Olmsted County, Minnesota, for the period 1980 to 2000, both consisting of predominantly White populations, reported an increase in the incidence of AF over time.[4,5] In contrast, a study of Medicare-insured patients aged ≥65 years from 1993 to 2007, a more recent analysis in Olmsted County, Minnesota (2000 to 2010), and the UK CPRD (Clinical Practice Datalink) study from 1998 to 2010 reported incidence rates (IRs) of AF that were fairly stable over time.[6–8] Questions remain on the accuracy of these contrasting results, whether these results can be generalized to other communities and other racial and ethnic groups, and whether they apply to the past decade. Current figures for trends in the incidence of

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CLINICAL PERSPECTIVE

What Is New?

- This study indicates that rates of atrial fibrillation have not changed in the community during the past 3 decades.
- No evidence that trends in the rates of atrial fibrillation are different by race, sex, or age group.

What Are the Clinical Implications?

- Reductions in the rates of stroke and coronary heart disease during the past decades have not been accompanied by reductions in the rates of atrial fibrillation, highlighting the need to develop preventive strategies for this common arrhythmia.

Nonstandard Abbreviations and Acronyms

ARIC	Atherosclerosis Risk in Communities
CPRD	Clinical Practice Datalink

AF in diverse communities in the United States are not available.

To address these gaps, we evaluated the trends in the incidence of AF among >15 000 White and Black participants from the ARIC (Atherosclerosis Risk in Communities) study, who were followed for over 30 years. The results obtained from this study provide insights into the future burden of AF in the general population.

METHODS

The data, analysis, and study materials are not available to other researchers for purposes of reproducing the results or replicating the analysis because of human participant restrictions. Interested investigators may contact the ARIC Study Center at the University of North Carolina to request access to ARIC study data.

Study Population

The ARIC study is a population-based prospective cohort study consisting of participants sampled from 4 US communities (mostly White individuals from the suburbs of Minneapolis, Minnesota, and Washington County, Maryland; Black individuals from Jackson, Mississippi; and White and Black individuals from Forsyth County, North Carolina).[9] The procedures were reviewed and approved by the institutional review board at the participating centers. Written informed consent was obtained from all participants. A detailed phone interview and clinical examination were performed to check the eligibility of the participants and collect baseline information. A cohort of 15 792 participants aged 45 to 64 years were enrolled during the period 1987 to 1989 (55% women, 27% Black). After an initial assessment, the participants were reexamined roughly every 3 years for 3 additional times until 1998, with further examinations in 2011 to 2013, 2016 to 2017, and 2018 to 2019.[10] Response rates for the first, second, and third follow-up examinations were 93%, 86%, and 80%, respectively. Contact with the participants was maintained yearly by phone (biannual since 2012) to ascertain their health status and obtain information about hospital admissions. For the purpose of the analysis, we included follow-up information through December 31, 2017.

Among the 15 792 participants, individuals with self-identified race American Indian, Alaskan Indian, Asian, or Pacific Islander (n=48) and Black from Minnesota and Maryland sites (n=55) were excluded, because of small numbers. Individuals with prevalent AF on ECG (n=37) and whose ECG was missing or unreadable (n=309) at baseline were excluded from the study. We included a total of 15 343 participants in the final study population for analysis purposes (Figure 1).

AF Event Ascertainment

The diagnosis of AF was obtained from 3 sources: ECGs at study examinations, recorded with MAC PC ECG machines (Marquette Electronics) in all clinical centers, hospital discharge records, and death certificates.[11,12] A resting 12-lead ECG recording was performed during the first 5 examinations for all ARIC participants. ECGs were transmitted to the ARIC Central ECG Reading Center by telephone for interpretation, storage, and coding. A trained cardiologist visually rechecked all automatically coded ECG recordings for AF to confirm the diagnosis.

International Classification of Diseases, Ninth Revision, Clinical Modification (*ICD-9-CM*; codes 427.31 or 427.32), and *International Classification of Diseases, Tenth Revision, Clinical Modification* (*ICD-10-CM*; code I48.x) hospital discharge diagnoses in the absence of cardiac procedures were obtained from hospitalization records to identify AF events. AF occurring during open heart surgeries was excluded. Finally, if AF (*ICD-10-CM* code I48 or *ICD-9-CM* code 427.3) was mentioned as a cause of death in the death certificate or in vital statistics obtained from National Death Index, then ARIC participants were classified as AF cases. The sensitivity and specificity by this approach was 80% and 99%, respectively, in Black individuals and 85% and 99%, respectively, in White individuals.[12] The incident date of AF was established as the date for the first ECG showing AF, the first hospital discharge

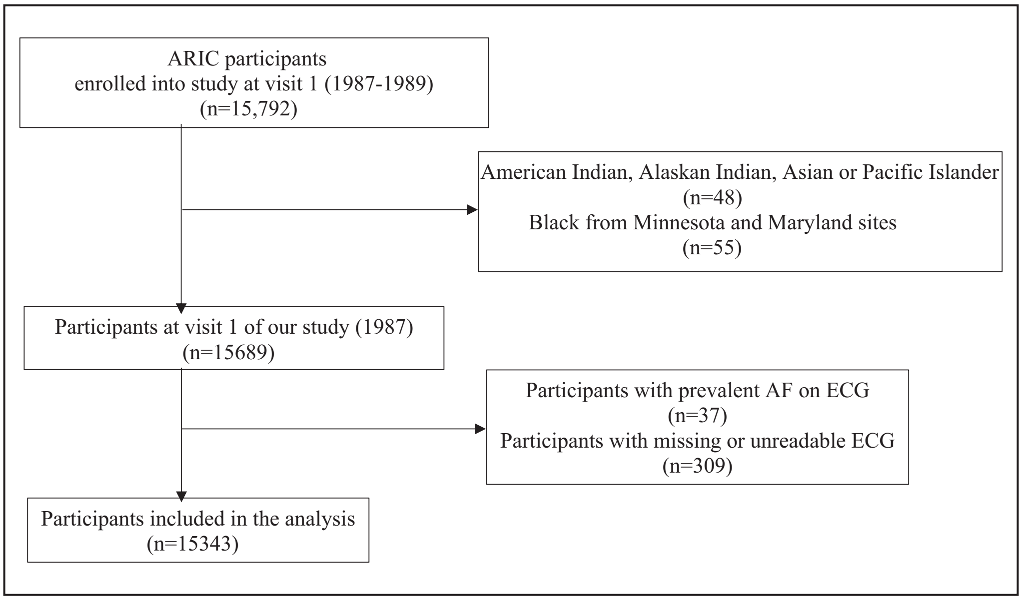

Figure 1. Study flow chart of participants in the ARIC (Atherosclerosis Risk in Communities) study, 1987 to 1989.
AF indicates atrial fibrillation.

with an AF or atrial flutter, or death by AF, whichever occurred earlier.

Ascertainment of Other Variables

Data at baseline were collected for body mass index (BMI), education level of the participant, smoking status, hypertension, and diabetes. Hypertension was defined as the use of antihypertensive medication or a systolic blood pressure ≥140 mm Hg or diastolic blood pressure ≥90 mm Hg. Evidence of previous myocardial infarction on ECG at baseline or a self-reported physician-diagnosed myocardial infarction was considered as having a history of myocardial infarction. Participants self-reported their smoking status and education level at baseline. Gothenburg criteria or treatment of heart failure in the past 2 weeks at baseline was identified as having prevalent heart failure.[13]

Statistical Analysis

Baseline characteristics for participants, stratified by race and sex, were summarized as percentages for categorical variables and mean (SD) for continuous variables.

We computed participants' person-years of follow-up from the date of first examination to the earliest of diagnosis of AF, loss to follow-up, or death. Age-specific IRs were calculated by 5-year age groups and calendar time by 5-year periods. The last calendar period was defined as a 6-year period (2012–2017), in order to include the most updated data. The crude IR was reported as the total number of events divided by the person-years of follow-up.

Temporal trends were reported using age-specific IRs of AF by 5-year calendar year periods. To visually assess the existence of temporal trends, age-specific crude IRs of AF by 5-year time periods were graphically plotted. We evaluated the impact of AF misclassification on rates correcting the number of cases by age and period group using the approach recommended by Greenland.[14] We calculated rate ratios (RRs) and their corresponding 95% CIs for periods using Poisson regression models with robust standard errors adjusting for age, sex, and race, using person-year as the unit of analysis. Similarly, we calculated rate differences and 95% Cis using multiple linear regression adjusting for age, sex, and race. We repeated these analyses adjusting for study site by creating a variable that combines race and site (White participants from Minnesota, White participants from Washington County, White participants from Forsyth County, Black participants from Forsyth County, and Black participants from Jackson). Analysis was performed using SAS 9.4 statistical software (SAS Institute Inc) for all of the data collected.

RESULTS

We analyzed 15 343 participants without AF at baseline and aged 45 to 64 years. Table 1 reports the baseline characteristics of the included participants by race and sex. The proportion of current smokers was highest among Black men. Likewise, the proportion of participants with only a basic education was higher among Black participants. The overall prevalence of risk factors for AF was higher in Black as compared with White participants.

A total of 3241 AF cases were identified during a mean follow-up of 22 years (SD, 8.4 years) (599 in Black participants, 2642 in White participants, 1582 in women, and 1659 in men). Participants underwent a mean of 3.8 ECGs (SD, 1.2) over the study period, with 71% undergoing 4 or 5 ECGs. Table 2 shows the different sources of AF ascertainment used to identify new incidence of AF during the follow-up years. Hospital discharge code only identified 82% of all AF cases, with 16% of the cases identified from ≥2 sources. The IR of AF in the entire cohort was 9.6 per 1000 person-years. Incidence of AF increased with increasing age (per 1000 person-years: 1.1 for <55 years, 4.1 for 55–64 years, 10.2 for 65–74 years, 22.6 for 75–84 years, and 39.3 for ≥85 years) and was higher in men compared with women and White compared with Black participants (per 1000 person-years: 11.6 in men, 8.1 in women, 10.5 in White, and 6.9 in Black participants). Race/center-specific IR were 11.8 per 1000 person-years for White participants in Washington County, 9.4 per 1000 person-years for White participants in Minneapolis, 7.0 per 1000 person-years for Black participants in Jackson, 10.3 per 1000 person-years for White participants in Forsyth, and 6.0 per 1000 person-years for Black participants in Forsyth. Age-specific IR by 5-year period did not show meaningful changes over time (Table 3 and Figures 2 and 3). Similarly, there was no strong evidence of increases over time in age-specific IR when stratified by race and sex group (Figure 4). Correcting IRs assuming different values for sensitivity and specificity in AF ascertainment resulted in the same patterns over time (Figure S1.)

The rate of AF was 45% higher in men compared with women (RR, 1.45; 95% CI, 1.36–1.56) and 32% higher in White compared with Black participants (RR, 1.32; 95% CI, 1.21–1.44), adjusting for age and period, in addition to including sex and race. In a model adjusted for sex, race, and age group, the RR of AF in 2012 to 2017 compared with 1987 to 1991 was 1.10 (95% CI, 0.88–1.36) (Table 4). Interactions between age group and calendar year were not significant, suggesting that temporal trends were not different by age group. A similar pattern was observed when estimating adjusted rate differences (Table 5), with the rate difference of AF in 2012 to 2017 compared with 1987 to 1991 being 0.6 per 1000 person-years (95% CI, −1.2 to 2.4). Analyses adjusting for race and center instead of just race provided similar results (Tables S1 and S2).

DISCUSSION

In our analysis of 15 343 participants aged 45 to 64 years followed for up to 30 years, we did not find any evidence of increased IRs of AF over time. Also, and as previously described, despite the prevalence of risk factors being higher in Black individuals, the IRs of AF were higher in White individuals. Consistent with previous population-based studies in the United States, the incidence of AF increased exponentially with age and was greater in men than in women.[4,5] Age-adjusted incidence in

Table 1. Baseline Characteristics of Study Participants in the ARIC Study, 1987 to 1989

	Overall	White men	White women	Black men	Black women
No. (%)	15 343 (100)	5332 (34.8)	5948 (38.8)	1539 (10.0)	2524 (16.4)
Age, mean (SD), y	54.2±5.8	54.8±5.7	54.0±5.7	54.0±6.0	53.3±5.7
BMI, mean (SD), kg/m^2	27.7±5.4	27.4±4.0	26.6±5.5	27.7±5.0	30.8±6.5
Education level, n (%)					
Less than high school	3622 (23.6)	960 (18.0)	978 (16.5)	677 (44.1)	1007 (40.0)
Completed high school	6262 (40.8)	2093 (39.3)	3022 (50.9)	400 (26.1)	747 (29.7)
At least some college	5435 (35.4)	2271 (42.7)	1943 (32.7)	457 (29.8)	764 (30.3)
Smoking, n (%)					
Current	4005 (26.1)	1311 (24.6)	1480 (24.9)	589 (38.3)	625 (24.8)
Former	4950 (32.3)	2534 (47.5)	1454 (24.5)	520 (33.8)	442 (17.5)
Never	6374 (41.5)	1486 (27.9)	3008 (50.6)	429 (27.9)	1451 (57.6)
Hypertension, n (%)	5324 (34.7)	1510 (26.2)	1551 (28.5)	839 (54.6)	1424 (56.7)
Diabetes, n (%)	1812 (11.8)	542 (10.2)	484 (8.2)	277 (18.3)	509 (20.8)
Prevalent heart failure, n (%)	709 (4.6)	148 (4.8)	280 (2.8)	65 (4.3)	216 (8.6)
Prevalent coronary heart disease, n (%)	735 (4.8)	464 (8.9)	109 (1.9)	89 (5.8)	73 (2.9)
Prevalent stroke, n (%)	275 (1.8)	86 (1.7)	104 (1.8)	30 (2.0)	55 (2.2)

ARIC indicates Atherosclerosis Risk in Communities; and BMI, body mass index.

Table 2. Sources of Incident Cases of AF in the ARIC Study, 1987 to 2017

Source	AF cases, n (%)
Hospital discharge code only	2670 (82.3)
Examination ECG only	32 (1)
Death certificate only	31 (1)
Both hospital discharge code and death certificate, no examination ECG	247 (7.6)
Both hospital discharge code and examination ECG, no death certificate	217 (6.7)
Both examination ECG and death certificate, no hospital discharge code	2 (0.1)
All 3 sources	42 (1.3)
Total	3241 (100)

The incident date of atrial fibrillation (AF) was established as the date of the first ECG that showed AF, the first hospital discharge with AF or atrial flutter, or death by AF, whichever occurred earlier. ARIC indicates Atherosclerosis Risk in Communities.

White men compared with White women were higher in both FHS and the Olmsted County, Minnesota, study. Comparable to the IRs being higher in White individuals, a prior analysis in the ARIC cohort reported a lifetime risk of developing AF of 1 in 3 among White individuals and 1 in 5 among Black individuals.[10]

Table 3. Crude Rates of AF (per 1000 PY) Stratified by 5-Year Age Group and 5-Year Calendar Year

	Calendar year of follow-up					
Age group, y	1987–1991	1992–1996	1997–2001	2002–2006	2007–2011	2012–2017
45–49						
IR (95% CI)	0.68 (0.3–1.3)	1.5 (0.2–5.5)				
Cases/PY	7/10 928	2/1318				
50–54						
IR (95% CI)	1.4 (0.8–2.1)	1.2 (0.7–1.9)	0.8 (0.02–4.4)			
Cases/PY	21/15 467	19/15 260	1/1275			
55–59						
IR (95% CI)	2.7 (1.9–3.7)	2.9 (2.2–3.7)	3.8 (2.8–4.9)	4.1 (1.5–9.1)		
Cases/PY	39/14 593	55/19 115	55/14 596	5/1206		
60–64						
IR (95% CI)	4.5 (3.5–5.8)	5.3 (4.2–6.5)	4.5 (3.5–5.6)	5.5 (4.4–6.9)	5.3 (1.9–11.6)	
Cases/PY	61/13 465	92/17 462	80/17 865	76/13 684	6/1123	
65–69						
IR (95% CI)	9.3 (6.5–12.8)	8.9 (7.5–10.6)	7.1 (5.9–8.8)	7.1 (5.9–8.5)	6.9 (5.5–8.5)	15.9 (9.1–25.8)
Cases/PY	37/3992	132/14 808	113/15 837	115/16 264	86/12 497	16/1005
70–74						
IR (95% CI)		13.1 (9.6–17.6)	14.3 (12.3–16.5)	12.2 (10.5–14.2)	11.6 (9.9–13.5)	14.6 (12.4–17.5)
Cases/PY		45/3426	183/12 787	168/13 704	166/14 266	161/11 017
75–79						
IR (95% CI)			15.1 (10.9–20.4)	20.3 (17.6–23.2)	20.8 (18.2–23.6)	19.0 (16.7–21.6)
Cases/PY			42/2780	209/10 290	231/11 096	237/12 459
80–84						
IR (95% CI)				23.3 (17.5–30.6)	32.1 (28.1–36.5)	27.3 (23.9–31.0)
Cases/PY				49/2097	233/7251	235/8598
85–89						
IR (95% CI)					47.9 (36.6–61.1)	36.7 (31.4–42.5)
Cases/PY					61/1273	173/4715
90–94						
IR (95% CI)						41.6 (28.1–59.3)
Cases/PY						30/721

AF indicates atrial fibrillation; IR, incidence rate; and PY, person-year.

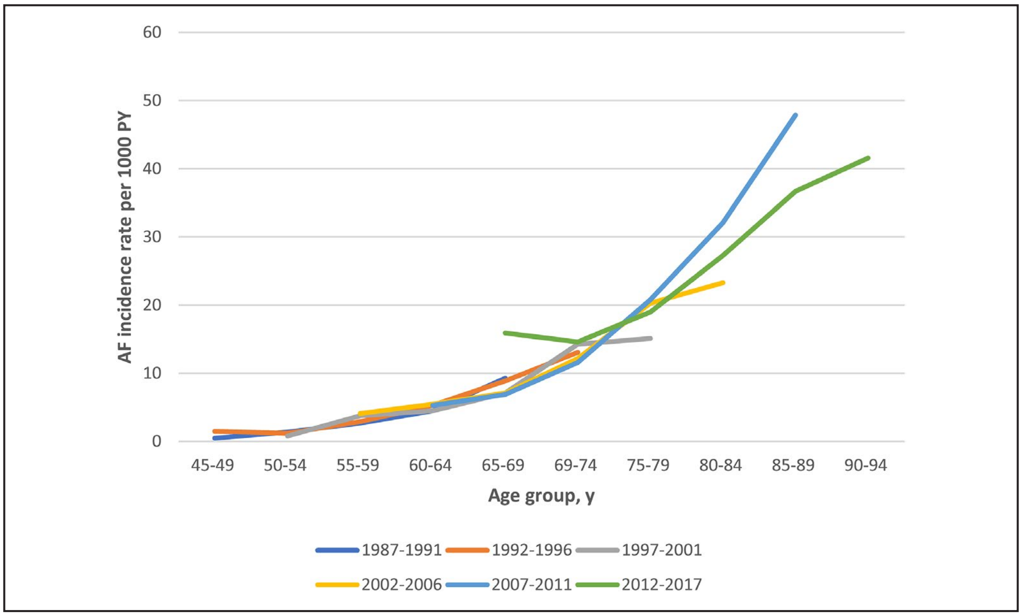

Figure 2. Age-specific incidence rates of atrial fibrillation (AF) by period in the ARIC (Atherosclerosis Risk in Communities) cohort, 1987 to 2017.
PY indicates person-years.

The Olmsted County, Minnesota, study reported an increasing trend in the age- and sex-adjusted incidence of AF from 1980 to 2000 (3.04 versus 3.68 per 1000 person-years).[4] Similar to these study results, FHS also showed an increase in the age-adjusted IR (1.83 per 1000 person-years in 1958–1967 versus 3.75 per 1000 person-years in 1998–2007) over time.[5] In contrast, a study of the UK CPRD from 1998 to 2010

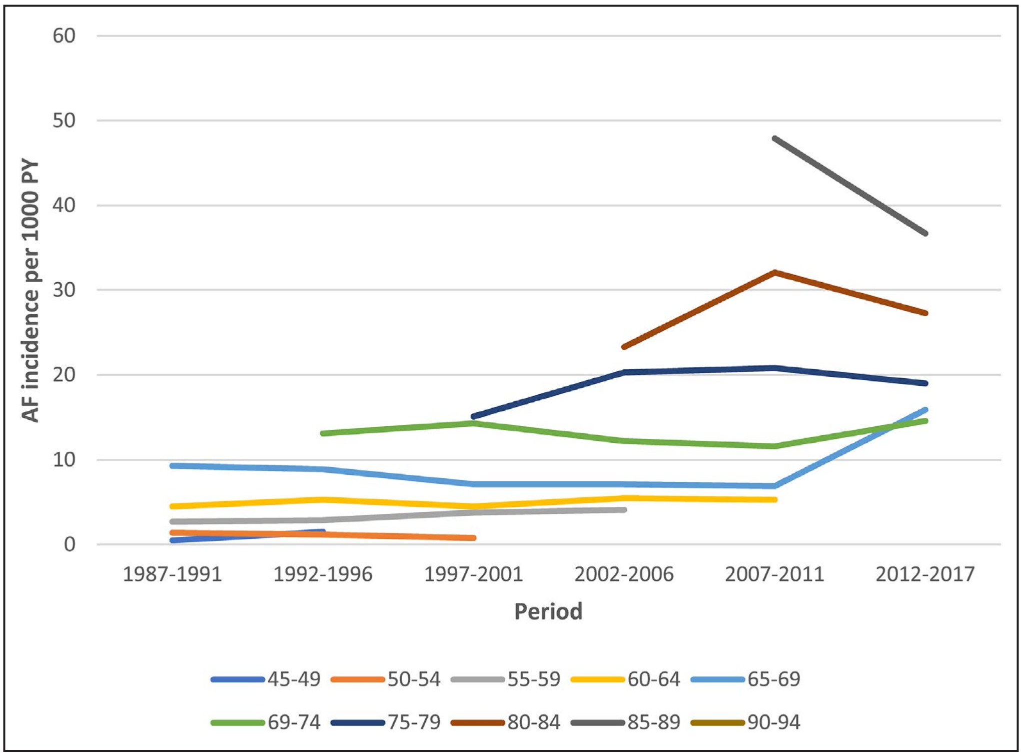

Figure 3. Period-specific incidence rates of atrial fibrillation (AF) by age in the ARIC (Atherosclerosis Risk in Communities) cohort, 1987 to 2017.
PY indicates person-years.

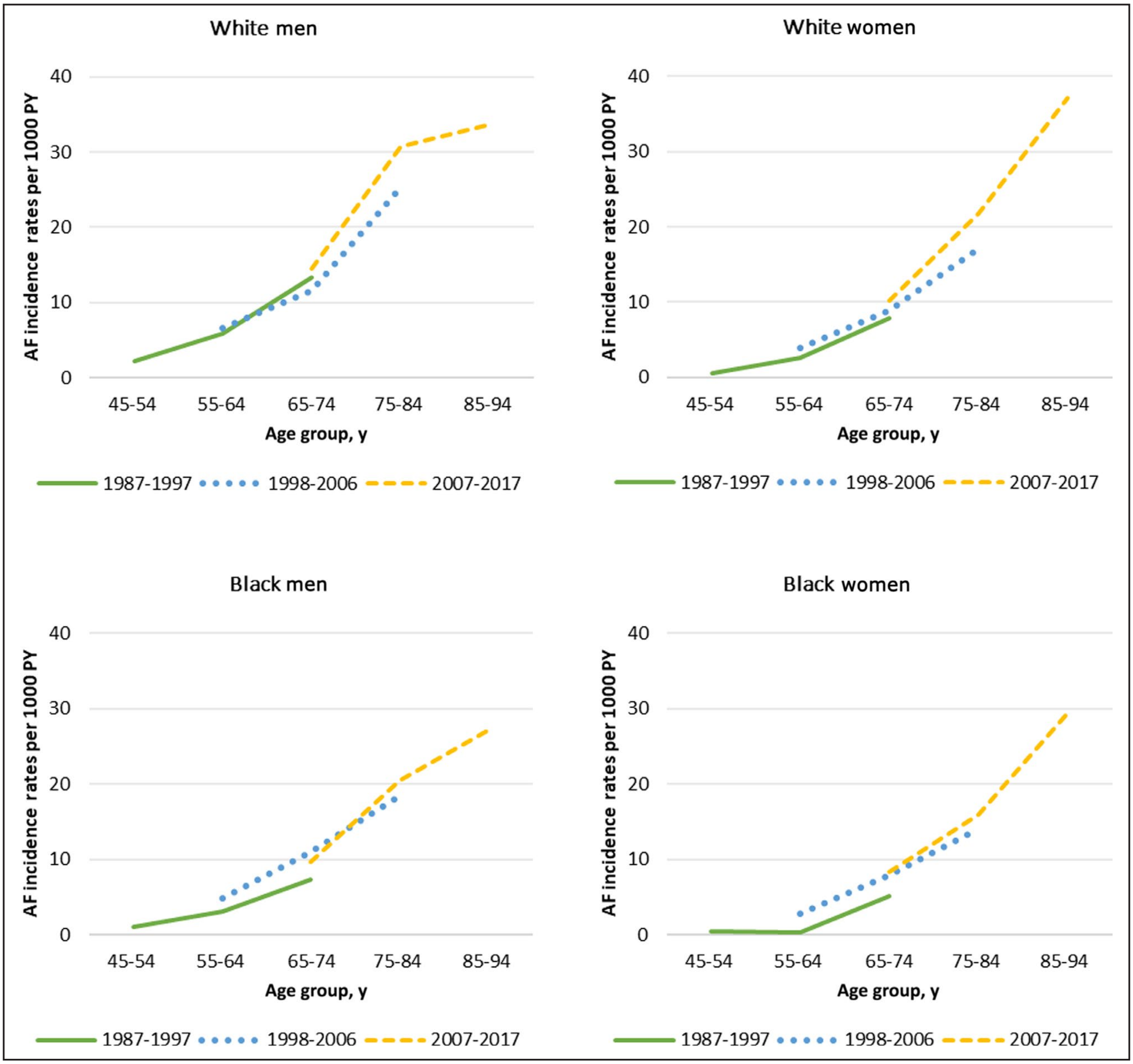

Figure 4. Age-specific incidence rates of atrial fibrillation (AF) by race, sex, and period in the ARIC (Atherosclerosis Risk in Communities) cohort, 1987 to 2017.
PY indicates person-years.

showed a fairly stable IR over time (1.11 in 1998–2001, 1.33 in 2002–2006, and 1.33 in 2007–2010).[8] Also, a more recent study of AF incidence in Olmsted County, Minnesota (2000–2010), did not report continued increases in AF incidence.[7] Our findings are consistent with both the UK CPRD study and the recent Olmsted County, Minnesota, study.[7,8] Inconsistencies among studies can be related to differences in the underlying populations and the periods under consideration, with a more diverse population and more recent periods in our analysis of the ARIC cohort compared with previous studies.

Although Black individuals have an underlying higher burden of risk factors compared with White individuals, we found lower overall rates of AF among the former racial group, after controlling for age, period, and sex. These findings are similar to those in other populations.[15–17] Reasons for this paradoxical difference in AF rates by race are currently unknown. A prior analysis in the ARIC cohort[18] indicated that these differences are unlikely to be explained by underascertainment of AF in Black participants attributable to lower socioeconomic status and poorer access to health care.

Table 4. RR for AF by Sex, Race, Age, and Period in the ARIC Study, 1987–2017

	RR	95% CI	*P* value
Sex (men vs women)	1.45	1.36–1.56	<0.0001
Race (White vs Black)	1.32	1.21–1.44	<0.0001
5-y age category			
45–49	1	Reference	
50–54	1.65	0.80–3.41	0.18
55–59	3.96	2.01–7.81	<0.0001
60–64	6.26	3.19–12.3	<0.0001
65–69	9.62	4.88–18.9	<0.0001
70–74	16.2	8.18–31.9	<0.0001
75–79	24.1	12.2–47.7	<0.0001
80–84	34.9	17.6–69.3	<0.0001
85–89	47.8	23.9–95.7	<0.0001
90–94	54.0	25.2–116	<0.0001
5-y period			
1987–1991	1	Reference	
1992–1996	1.11	0.92–1.35	0.26
1997–2001	1.05	0.87–1.28	0.60
2002–2006	1.05	0.86–1.29	0.62
2007–2011	1.12	0.91–1.38	0.28
2012–2017	1.10	0.88–1.36	0.40

Results are from Poisson regression model including all variables in the table. AF indicates atrial fibrillation; ARIC, Atherosclerosis Risk in Communities; and RR, rate ratio.

Table 5. Rate differences for AF by Sex, Race, Age, and Period in the ARIC Study, 1987 to 2017

	Rate difference (per 1000 person-years)	95% CI	*P* value
Sex (men vs women)	3.7	3.0 to 4.3	<0.0001
Race (White vs Black)	2.3	1.5 to 3.0	<0.0001
5-y age category			
45–49	Reference		
50–54	0.2	−1.8 to 2.3	0.82
55–59	2.0	−0.1 to 4.0	0.06
60–64	3.7	1.7 to 5.8	0.0003
65–69	6.4	4.3 to 8.5	<0.0001
70–74	11.6	9.4 to 13.9	<0.0001
75–79	18.1	15.7 to 20.5	<0.0001
80–84	27.2	24.5 to 29.8	<0.0001
85–89	37.5	34.2 to 40.9	<0.0001
90–94	40.4	32.9 to 47.9	<0.0001
5-y period			
1987–1991	Ref		
1992–1996	0.5	−0.6 to 1.7	0.35
1997–2001	0.3	−0.9 to 1.5	0.64
2002–2006	0.2	−1.2 to 1.6	0.75
2007–2011	1.0	−0.5 to 2.6	0.19
2012–2017	0.6	−1.2 to 2.4	0.50

Results are from linear regression model including all variables in the table. AF indicates atrial fibrillation; and ARIC, Atherosclerosis Risk in Communities.

Several studies among Europe,[19–21] New Zealand,[22] Western Australia,[23] Japan,[24] and the United States[25–27] have demonstrated decreasing trends in stroke and coronary heart disease incidence over the past few decades. This decline in cardiovascular disease incidence has been attributed to reductions in the prevalence of risk factors for cardiovascular disease, better management of these risk factors, and improved medical care.[28] These positive trends in stroke and coronary heart disease, however, have not been accompanied by reductions in AF incidence, as shown in our current analysis of the ARIC cohort and other studies, despite some risk factors being shared between these conditions. These discrepancies highlight the importance of developing specific strategies for the prevention of AF that go beyond current approaches for prevention and control of overall cardiovascular disease.

Strengths and Limitations

The ARIC cohort has a large sample size and a diverse population with an extended follow-up time, which allows the estimated IRs to be precise, even among race and sex groups. As this is one of the longest follow-up studies with a biracial population in 4 communities among the United States, the cohort is more diverse than other studies, thus facilitating generalizability of the results. The study also benefits from excellent follow-up, careful participant assessments, and availability of repeated ECGs and information on hospitalizations.

One major limitation of the study is the ascertainment of AF. Asymptomatic AF or those cases managed in outpatient care will be missed as the ascertainment of AF is based primarily on hospital discharge codes. In addition, we are unable to differentiate between paroxysmal AF and persistent AF based on study ECG and hospital discharge records. Participants in the ARIC study were born between 1920 and 1945. Thus, the observed trends in AF incidence may not be applicable to individuals from more recent birth cohorts. Also, the relatively narrow age range at baseline limits the ability to study trends among all age groups. Finally, since most of the black participants come from the Jackson site, it is not possible to perfectly disentangle race differences from differences in location.

CONCLUSIONS

We report that the IRs of AF in a large biracial population–based closed cohort in 4 different US communities did not change over time from 1987 to 2017. The increasing incidence of AF with increasing age helps to understand the burden of AF and its public health impact. A careful evaluation is needed to fully understand the risk factors and get insights into the mechanism causing racial discrepancy in the incidence of AF. Future studies should address the issue of continuous monitoring of participants for subclinical AF as well as develop strategies aimed in reducing the burden of AF in the population.

ARTICLE INFORMATION

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Disclosures

None.

Supplemental Material

Tables S1–S2
Figure S1

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SUPPLEMENTAL MATERIAL

Table S1. Rate ratio for AF by sex, center - race, age and period in the Atherosclerosis Risk in Communities Study, 1987-2017.

	Rate Ratio	95% CI	p-value
Sex (Male vs Female)	1.46	1.36, 1.56	<0.0001
Center – Race			
Minnesota White	1	Ref.	
Washington Co. White	1.21	1.11, 1.33	<0.0001
Forsyth Co. White	1.09	0.99, 1.20	<0.08
Forsyth Co. Black	0.71	0.54, 0.94	0.02
Jackson Black	0.85	0.77, 0.95	0.004
5-year Age category			
45-49	1	Ref	
50-54	1.65	0.80, 3.40	0.18
55-59	3.93	1.99, 7.76	<0.0001
60-64	6.21	3.17, 12.2	<0.0001
65-69	9.52	4.83, 18.8	<0.0001
70-74	16.0	8.08, 31.5	<0.0001
75-79	23.7	12.0, 47.0	<0.0001
80-84	34.3	17.3, 68.1	<0.0001
85-89	46.9	23.4, 93.9	<0.0001
90-94	52.7	24.6, 113	<0.0001
5-year Period			
1987-1991	1	Ref	
1992-1996	1.12	0.92, 1.35	0.26
1997-2001	1.06	0.87, 1.29	0.57
2002-2006	1.06	0.86, 1.30	0.58
2007-2011	1.13	0.92, 1.39	0.25
2012-2017	1.11	0.89, 1.38	0.34

Results from Poisson regression model including all variables in the table.

Table S2. Rate differences for AF by sex, center - race, age and period in the Atherosclerosis Risk in Communities Study, 1987-2017.

	Rate Difference (per 1000 person-years)	95% CI	p-value
Sex (Male vs Female)	3.7	3.0, 4.4	<0.0001
Center – Race			
Minnesota White	Ref		
Washington Co. White	2.1	1.1, 3.0	<0.0001
Forsyth Co. White	0.8	-0.2, 1.7	0.11
Forsyth Co. Black	-2.5	-4.6, -0.4	0.02
Jackson Black	-1.2	-2.1, -0.3	0.01
5-year Age category			
45-49	Ref		
50-54	0.2	-1.9, 2.3	0.85
55-59	1.9	-0.1, 3.9	0.06
60-64	3.7	1.6, 5.7	0.0004
65-69	6.3	4.2, 8.4	<0.0001
70-74	11.5	9.3, 13.7	<0.0001
75-79	17.9	15.6, 20.3	<0.0001
80-84	27.0	24.3, 29.6	<0.0001
85-89	37.3	34.0, 40.7	<0.0001
90-94	40.1	32.7, 47.6	<0.0001
5-year Period			
1987-1991	Ref		
1992-1996	0.6	-0.6, 1.7	0.33
1997-2001	0.3	-0.9, 1.6	0.58
2002-2006	0.3	-1.1, 1.7	0.68
2007-2011	1.1	-0.4, 2.7	0.16
2012-2017	0.7	-1.1, 2.5	0.43

Results from linear regression model including all variables in the table.

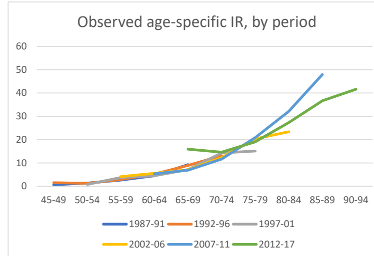
Figure S1. Incidence rates corrected by imperfect sensitivity and specificity

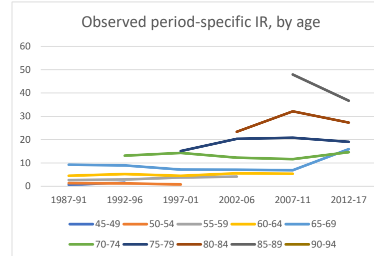
Sensitivity	90.0%	<--Provide values of sensitivity and specificity
Specificity	99.9%	

agegroup	period	a_star	pt	ir_star	a	ir
45-49	1987-91	7	10928	0.6	-4	-0.4
50-54	1987-91	21	15467	1.4	6	0.4
55-59	1987-91	39	14593	2.7	27	1.9
60-64	1987-91	61	13465	4.5	53	3.9
65-69	1987-91	37	3992	9.3	37	9.2
45-49	1992-96	2	1318	1.5	1	0.6
50-54	1992-96	19	15260	1.2	4	0.3
55-59	1992-96	55	19115	2.9	40	2.1
60-64	1992-96	92	17462	5.3	83	4.7
65-69	1992-96	132	14808	8.9	130	8.8
70-74	1992-96	45	3426	13.1	46	13.5
50-54	1997-01	1	1275	0.8	0	-0.2
55-59	1997-01	55	14596	3.8	45	3.1
60-64	1997-01	80	17865	4.5	69	3.9
65-69	1997-01	113	15837	7.1	108	6.8
70-74	1997-01	183	12787	14.3	189	14.8
75-79	1997-01	42	2780	15.1	44	15.7
55-59	2002-06	5	1206	4.1	4	3.5
60-64	2002-06	76	13684	5.6	69	5.1
65-69	2002-06	115	16264	7.1	110	6.7
70-74	2002-06	168	13704	12.3	171	12.5
75-79	2002-06	209	10290	20.3	221	21.5
80-84	2002-06	49	2097	23.4	52	24.9
60-64	2007-11	6	1123	5.3	5	4.8
65-69	2007-11	86	12497	6.9	82	6.5
70-74	2007-11	166	14266	11.6	169	11.8
75-79	2007-11	231	11096	20.8	244	22.0
80-84	2007-11	233	7251	32.1	251	34.6
85-89	2007-11	61	1273	47.9	66	52.1
65-69	2012-17	16	1005	15.9	17	16.6
70-74	2012-17	161	11017	14.6	167	15.1
75-79	2012-17	237	12459	19.0	249	20.0
80-84	2012-17	235	8598	27.3	252	29.3
85-89	2012-17	173	4715	36.7	187	39.7
90-94	2012-17	30	721	41.6	33	45.1

Observed age and period-specific rates

	1987-91	1992-96	1997-01	2002-06	2007-11	2012-17
45-49	0.6	1.5				
50-54	1.4	1.2	0.8			
55-59	2.7	2.9	3.8	4.1		
60-64	4.5	5.3	4.5	5.6	5.3	
65-69	9.3	8.9	7.1	7.1	6.9	15.9
70-74		13.1	14.3	12.3	11.6	14.6
75-79			15.1	20.3	20.8	19.0
80-84				23.4	32.1	27.3
85-89					47.9	36.7
90-94						41.6





Corrected age and period-specific rates

	1987-91	1992-96	1997-01	2002-06	2007-11	2012-17
45-49	-0.4	0.6				
50-54	0.4	0.3	-0.2			
55-59	1.9	2.1	3.1	3.5		
60-64	3.9	4.7	3.9	5.1	4.8	
65-69	9.2	8.8	6.8	6.7	6.5	16.6
70-74		13.5	14.8	12.5	11.8	15.1
75-79			15.7	21.5	22.0	20.0
80-84				24.9	34.6	29.3
85-89					52.1	39.7
90-94						45.1