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Atrial fibrillation fact sheet in Korea 2024 (part 1): epidemiology of atrial fibrillation in Korea

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Abstract

Background and objectives This study aimed to analyze and present updated trends in atrial fibrillation (AF) epidemiology within the Korean population, providing a foundation for planning and implementing appropriate management and treatment strategies for patients with AF.

Patients and methods We used the Korean National Health Insurance Service database to evaluate the prevalence, incidence, comorbidities, and clinical adverse outcomes of patients with AF in Korea between 2013 and 2022.

Results AF prevalence in Korean adults aged ≥ 20 years doubled (1.1 to 2.2%) between 2013 and 2022, with significant increases observed across various sex and age groups. Similarly, the number of newly diagnosed patients with AF per year increased steadily, with the incidence rising from 184 to 275 per 100,000 person-years, particularly among older populations. Over this period, the mean age of patients with AF increased from 67.7 to 70.3 years, and comorbidities prevalence and CHA_2DS_2-VASc score rose significantly, indicating a higher stroke risk. Compared with patients without AF, AF was associated with an increased risk of mortality (hazard ratio [HR]: 1.78), ischemic stroke (HR: 2.39), major bleeding (HR: 2.10), myocardial infarction (HR: 1.44), and heart failure admission (HR: 2.42).

Conclusion AF prevalence and incidence have steadily increased between 2013 and 2022, with a more pronounced increase in older patients. Patients with AF are increasingly becoming a high-risk population and are at increased risk of clinical adverse outcomes compared to non-AF patients. Therefore, a sustained national effort to improve AF awareness and comprehensive care quality for patients with AF is required.

Keywords Atrial fibrillation, Prevalence, Incidence, Comorbidity, Stroke

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Introduction

Atrial fibrillation (AF) represents the most prevalent sustained cardiac arrhythmia in the general population. The rising aging population and age-related comorbidities contribute significantly to the increase in AF cases [1, 2]. AF complicates other medical conditions, leading to more frequent hospitalizations and a growing healthcare burden [3–6]. Its prevalence is expected to rise to 12 million people in the USA by 2050 and 17.9 million in Europe by 2060 [7, 8]. The demographic distribution of AF in developed nations is anticipated to shift towards older age groups in the coming years. AF portends an increasing public health burden as populations age, necessitating accurate prevalence and incidence data for clinicians and policymakers [9]. In Korea, the past decade has seen a 4.2-fold increase in hospitalizations due to AF, with the total cost of care rising by approximately 5.7-fold [5].

Patients with AF face higher risks of mortality and morbidities, particularly from heart failure (HF), dementia, and ischemic stroke, than those without AF [10–13]. Recent advancements have been made in pharmacological and non-pharmacological treatments for AF and related conditions such as hypertension, myocardial infarction (MI), and HF [14–17]. However, most of the current understanding of the incidence, prevalence, and associated cardiovascular morbidity and mortality of AF comes from Western countries.

Our study examined the temporal trends in the prevalence and incidence of AF, the risks of cardiovascular events, and all-cause mortality using the National Health Insurance Service (NHIS) database covering the entire Korean population between 2013 and 2022.

Patients and methods

Data sources and study population

This study utilized data from the Korean NHIS claims database (NHIS-2023-1-827) [18, 19]. Participation in the Korean NHIS is mandatory for all Koreans, with insurance premiums proportional to individual income. Approximately 97.1% of the Korean population subscribes to this system. The remaining 3%, consisting primarily of individuals with low income, are covered by the Medical Aid program, and since 2006, their information has been integrated into the Korean NHIS database. Consequently, the NHIS database encompasses the Korean population, eliminating selection bias. The database provides comprehensive medical information, including patients' sociodemographic data, utilization of inpatient and outpatient services, pharmacy dispensing claims, and mortality records. All individuals in the Korean NHIS database are linked through Korean social security numbers, which are anonymized by replacing them with serial numbers to protect personal information. These databases are granted access to researchers whose study protocols received approval from the official review committee. This study adhered to the principles outlined in the Declaration of Helsinki and was approved by the institutional review board of Seoul National University Hospital (E-2306-004-1435), with a waiver for informed consent. This study utilized already anonymized claims data, which means that consent could not be obtained from the subjects included in the study, and an exemption from obtaining consent has been obtained from the institutional review board. This analysis included data from the entire Korean population aged ≥ 20 years from January 1, 2002, to December 31, 2022.

Prevalence and incidence of AF

To be classified as a patient with AF, a diagnosis must have been made between January 1, 2002, and December 31, 2022, with the index date defined as the first date of diagnosis within this observation period. AF was identified using the International Classification of Disease 10th Revision (ICD-10) codes I48.0–I48.4 and I48.9 [1]. Patients were considered to have AF only if it was a discharge diagnosis or confirmed at least twice in outpatient settings to ensure diagnostic accuracy. The diagnosis of AF has been previously validated in the NHIS database, demonstrating a positive predictive value of 94.1% [20, 21]. Patients aged < 20 years and those with valvular heart disease (mitral stenosis [I05.0, I05.2, I05.9] or prosthetic heart valves [Z95.2-Z95.4]) were excluded from the study [1].

The annual prevalence of AF was calculated by dividing the number of patients with AF who were alive at the end of each year by the total number of Korean residents alive at the end of that year. Supplementary Table 1 provides the number and distribution of the total Korean residents aged ≥ 20 years. This study analyzed the annual prevalence of AF between 2013 and 2022.

The annual incidence of AF was defined as the rate of new AF diagnoses in the health claims data within 1 year. The year of diagnosis was determined by the first date the AF-related ICD-10 codes were recorded, and the initial 11 years (2002 to 2012) were excluded to avoid misclassifying preexisting AF as incident AF. The annual incidence rate of AF was calculated by dividing the number of new AF cases by the number of person-years at risk among all Korean residents who were never diagnosed with AF in that year. Incidence rates were presented per 100,000 person-years. This study analyzed the annual incidence of AF between 2013 and 2022.

Prevalence and incidence were calculated by sex (male and female) and age groups (20–29, 30–39, 40–49, 50–59,

60–69, 70–79, and ≥ 80 years). For AF prevalence, data for patients aged ≥ 60 years were reported separately.

Definitions of comorbidities and adverse outcomes

Patient comorbidities were identified to describe the baseline characteristics of patients with prevalent AF between 2013 and 2022. The comorbidities assessed included hypertension, diabetes, HF, prior ischemic stroke, prior transient ischemic attack (TIA), MI, and peripheral artery disease, using data from up to 5 years before the year of prevalent AF. The CHA_2DS_2-VASc score was calculated based on these comorbidities [21, 22]. Supplementary Table 2 provides detailed definitions of comorbidities.

As patients age and accumulate more comorbidities over time [23], their CHA_2DS_2-VASc score, which represents stroke risk, is likely to increase. To investigate this within the same population, we analyzed year-to-year changes in comorbidities and CHA_2DS_2-VASc scores between 2017 and 2022 in a cohort of 458,666 patients admitted with prevalent AF in 2017 who survived until 2022.

The epidemiological trends of adverse outcomes, including all-cause mortality, ischemic stroke, major bleeding, MI, HF admission, and dementia, were evaluated. The diagnostic accuracies of these outcomes in the Korean NHIS have been validated previously [18, 24–27]. Supplementary Table 2 presents the definitions of adverse outcomes.

Statistical analyses

Continuous variables were presented as means and standard deviations, and categorical variables as numbers and proportions. The Cochran-Armitage trend test was employed to analyze temporal trends in categorical variables. For continuous variables, the nonparametric Jonckheere-Terpstra test for trend was utilized.

The annual incidence rate (% per year) of adverse outcomes was evaluated among patients with prevalent AF by dividing the number of first-time events that occurred each year by the total number of patients at the beginning of the year who had never experienced the event. Adverse outcomes in the non-AF Korean population were assessed using an age- and sex-matched cohort from the Korean NHIS-National Sample Cohort database. Participants without AF were enrolled through age- and sex-matched sampling methods incorporating the propensity score, with a 1:2 case-to-control ratio, using patients with prevalent AF as the case group at the beginning of 2017. The adverse event rates among the matched AF and non-AF participant groups were analyzed from the beginning of 2017 to the end of 2019, providing a 3-year follow-up duration. The risk of adverse outcomes with and without AF was compared using Cox regression analyses.

All tests were two-tailed, and a $p < 0.05$ was deemed statistically significant. Statistical analyses were performed using SAS version 9.4 (SAS Institute, Cary, NC, USA).

Results

Prevalence of AF

In Korean adults aged ≥ 20 years, the number of patients with prevalent AF increased from 43,769 in 2013 to 940,063 in 2022, with the prevalence doubling from 1.1 to 2.2% over this time (p-for-trend < 0.001, Fig. 1A). This increasing trend in AF prevalence was significant in both men and women (p-for-trend < 0.001 in both men and women, Fig. 1B), with a 2022 AF prevalence of 2.4% in men and 2.0% in women. The steady increase in AF prevalence between 2013 and 2022 was also significant in various age-specific analyses (all p-for-trend < 0.001, Fig. 1C). Older patients consistently exhibited a higher prevalence of AF throughout the study period. Additionally, the year-to-year increase in AF prevalence was more pronounced in the older population (Fig. 1C). Notably, within the population aged ≥ 60 years, the number of patients with AF markedly increased from 32,614 in 2013 to 75,518 in 2022 (Fig. 2A). Concurrently, the AF prevalence rose from 3.9% in 2013 to approximately 5.7% in 2022 in participants aged ≥ 60 years (Fig. 2B). In 2022, when we evaluated the AF prevalence by age in 1-year increments, the first age group to have an AF prevalence of ≥4% was the 67-year age group, and the population aged 67 years and older had an AF prevalence of 4% or higher in every 1-year age group.

The prevalence of AF exhibited slight regional variation, with Jeonbuk reporting the highest prevalence at 3.5% in 2022 and Sejong City reporting the lowest at 1.6% (Fig. 3). Comparative analysis between urban and suburban/rural areas revealed a significantly higher prevalence in suburban/rural areas than urban areas (2.4% vs. 1.9%, $p < 0.001$).

Incidence of AF

Between 2013 and 2022, the number of newly diagnosed patients with AF per year steadily increased (Fig. 4A). The incidence of AF increased from 184 per 100,000 person-years in 2013 to 275 per 100,000 person-years in 2022, reflecting a 1.5-fold increase over the 10 years (p-for-trend < 0.001, Fig. 4B). This rise in AF incidence was significant in both men and women (p-for-trend < 0.001 for both, Fig. 4C), with the 2022 incidence rates reaching 301 per 100,000 person-years in men and 249 per 100,000

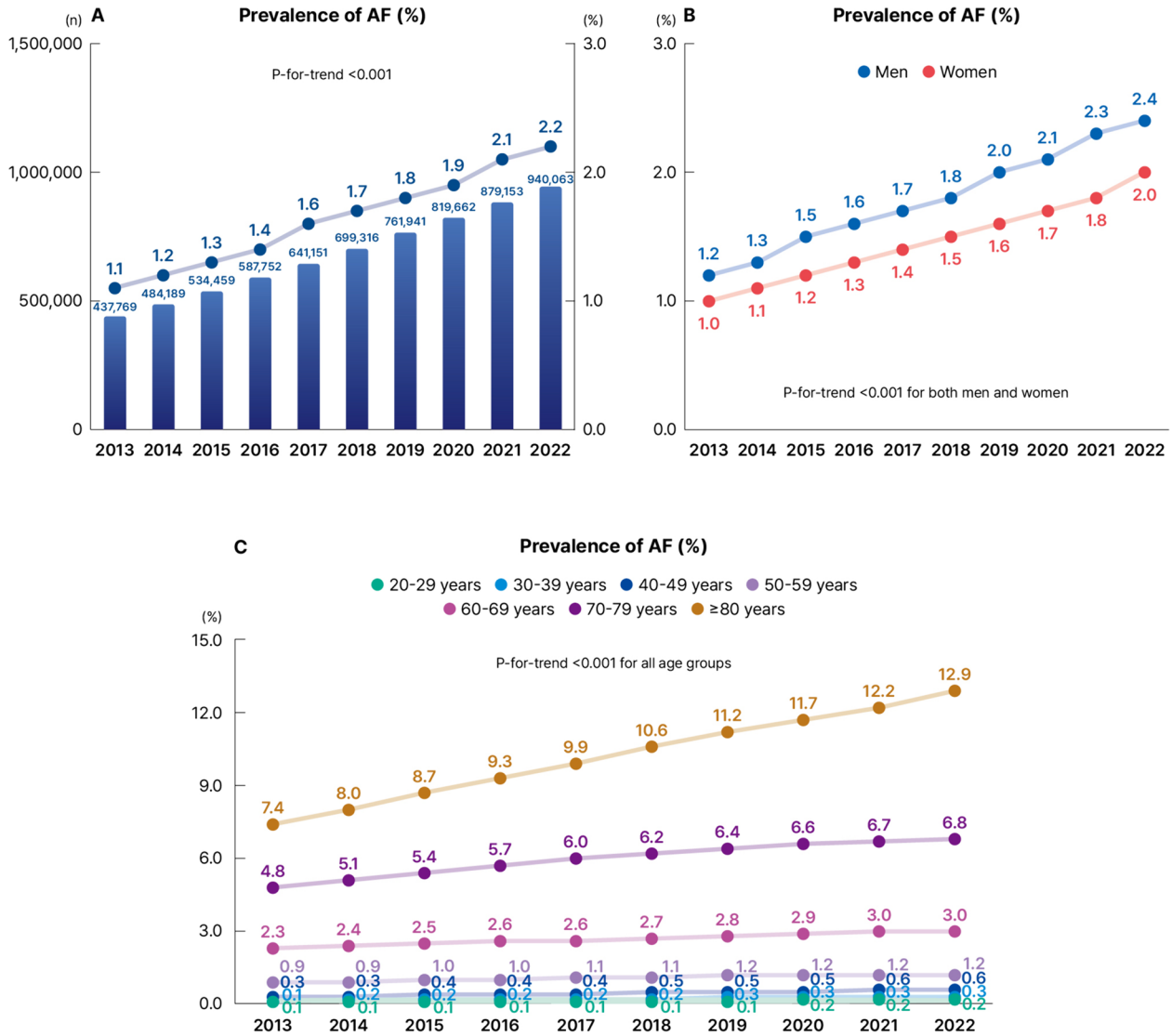

Fig. 1 Prevalence of atrial fibrillation between 2013 and 2022. **A** Prevalence of atrial fibrillation and number of patients with prevalent atrial fibrillation in the entire Korean adults. **B** Prevalence of atrial fibrillation in according to the sex. **C** Prevalence of atrial fibrillation in according to the different age groups. Abbreviation: AF, atrial fibrillation

person-years in women. Similar to the prevalence patterns, AF incidence was higher among older populations, with a more pronounced increase observed in these groups (Fig. 4D). Specifically, the incidence of AF in individuals aged ≥ 80 years reached 1903 per 100,000 person-years in 2022.

Changes in age and comorbidities of patients with prevalent AF

Table 1 details the characteristics of all patients with AF between 2013 and 2022. Over these 10 years, the mean age of patients with AF increased gradually from 67.7 to 70.3 years (p-for-trend < 0.001, Fig. 5A). The proportion of the older population aged ≥ 75 years significantly rose from 34.9% in 2017 to 54.9% in 2022 (p-for-trend < 0.001, Fig. 5B). Comorbidities, including hypertension, diabetes, HF, prior ischemic stroke, TIA, and MI, showed a consistent increase throughout the decade (Fig. 5C); this was accompanied by a rise in the mean CHA_2DS_2-VASc score from 3.3 points in 2017 to 3.6 points in 2022, along with a gradual increase in the proportion of patients with higher CHA_2DS_2-VASc scores (p-for-trend < 0.001, Fig. 6).

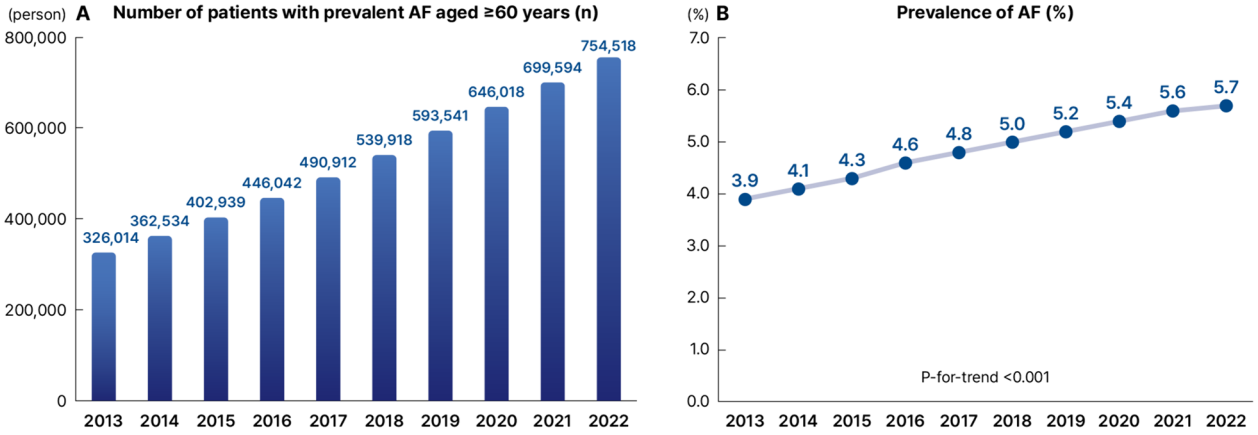

Fig. 2 Prevalence of atrial fibrillation in subjects aged ≥ 60 years. **A** Number of patients with prevalent atrial fibrillation aged ≥ 60 years. **B** Prevalence of atrial fibrillation in subjects aged ≥ 60 years. Abbreviation: AF, atrial fibrillation

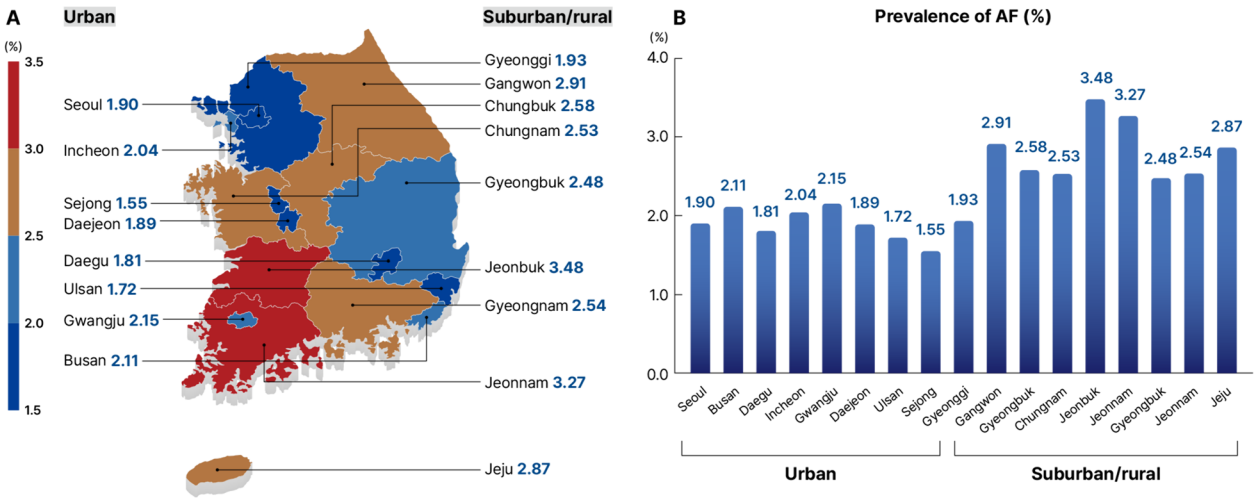

Fig. 3 Regional difference of prevalence of atrial fibrillation. **A** Prevalence of atrial fibrillation in different regions in Korea. **B** Prevalence of atrial fibrillation in urban and suburban/rural area in Korea. Abbreviation: AF, atrial fibrillation

Increasing age, comorbidities, and stroke risk over time in the same patients with AF

Examining the changes in baseline characteristics among the 458,666 patients who entered the cohort with prevalent AF in 2017 and survived until 2022, we observed a substantial increase in the proportion of patients aged ≥ 75 years, rising from 27.7% in 2017 to 42.3% in 2022 (p-for-trend < 0.001, Table 2). Over this period, the prevalence of comorbidities, including hypertension, diabetes, HF, prior ischemic stroke, prior TIA, and MI, also increased. Consequently, the mean CHA_2DS_2-VASc score rose from 2.9 ± 1.8 in 2017 to 3.4 ± 1.9 in 2022, and the proportion of patients with a CHA_2DS_2-VASc score of ≥ 2 increased from 74.5% in 2017 to 81.7% in 2022.

Risk of adverse clinical outcomes associated with AF

Among the patients with prevalent AF, the annual event rates for ischemic stroke and major bleeding declined for the decade. In contrast, those for all-cause mortality, HF admission, and MI increased (all p-for-trend < 0.001, Fig. 7A). The annual event rate for dementia did not change significantly. Compared with patients without AF, AF was associated with an increased risk of mortality (hazard ratio [HR]: 1.78; 95% confidence interval [CI] 1.67–1.89), ischemic stroke (HR: 2.39; 95% CI 1.98–2.88), major bleeding (HR: 2.10; 95% CI 1.53–2.87), MI (HR: 1.44; 95% CI 1.09–1.91), and HF admission (HR: 2.42; 95% CI 1.88–3.11) (Fig. 7B and Supplementary Table 3).

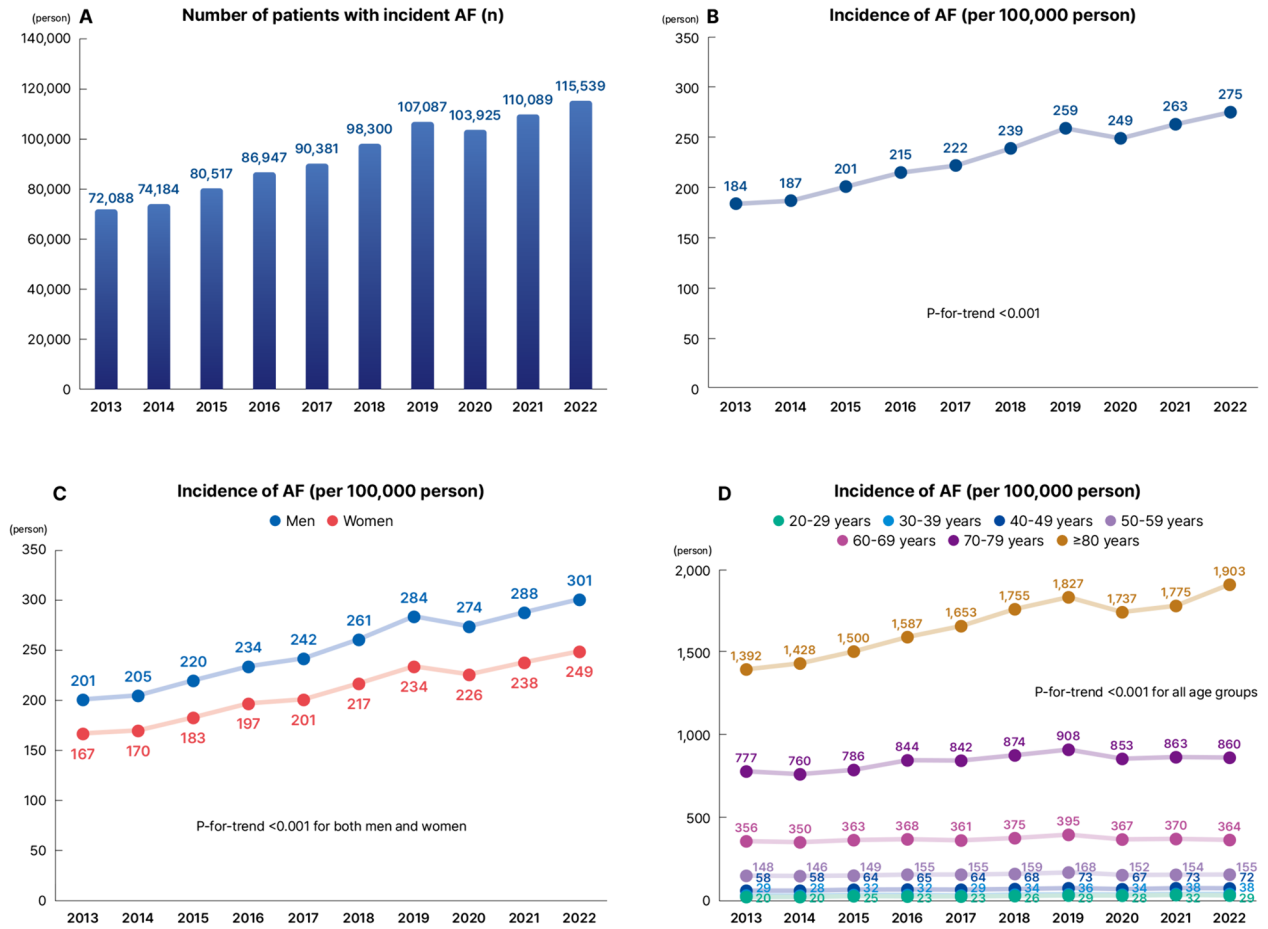

Fig. 4 Incidence of atrial fibrillation. **A** Number of patients with newly diagnosed atrial fibrillation from 2013 to 2022. **B** Incidence of atrial fibrillation. **C** Incidence of atrial fibrillation according to the sex. **D** Incidence of atrial fibrillation according to the different age groups. Abbreviation: AF, atrial fibrillation

Discussion

Our principal findings in this large nationwide cohort study of a Korean population are as follows: (1) between 2013 and 2022, the prevalence of AF in Korean adults aged ≥ 20 years doubled from 1.1 to 2.2%; (2) the number of newly diagnosed patients with AF per year also increased steadily, with the incidence rising from 184 to 275 per 100,000 person-years, particularly among older populations; (3) over this period, the mean age of patients with AF increased from 67.7 to 70.3 years, and the prevalence of comorbidities and the CHA_2DS_2-VASc score rose significantly, indicating a higher stroke risk; and (4) compared with patients without AF, AF was associated with an increased risk of mortality, ischemic stroke, major bleeding, MI, and HF admission.

Over a decade of observation, we noted a continuously increasing prevalence of AF, consistent with findings from most Asian and Western populations. [10, 28–30] The prevalence increased steadily across all age groups and sexes, with a particularly significant rise among older individuals, reaching 5.7% among those aged ≥ 60 years in 2022. Suburban and rural areas showed higher prevalence rates, aligning with previous reports [31]. A previous report showed that the prevalence of AF and antithrombotic therapy are closely linked to geographical location and income levels [31]. A cross-sectional analysis of Korean adults across 17 regions revealed a notable correlation between regional AF and stroke prevalence. This underscores the importance of emphasizing AF prevention, screening, detection, and treatment in medically underserved areas.

Table 1 Characteristics of the patients with prevalent AF in Korea bewteen 2013 and 2022

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	*P* for trend
Prevalent AF, n	437,769	484,189	534,459	587,752	641,151	699,316	761,941	819,662	879,153	940,063	
Age (years)	67.7 ± 13.6	68 ± 13.7	68.2 ± 13.8	68.5 ± 13.9	68.8 ± 13.9	69.1 ± 14	69.4 ± 14	69.7 ± 14	70 ± 14.1	70.3 ± 14.1	< 0.001
< 65 years	156,166 (35.7)	170,433 (35.2)	186,737 (34.9)	204,488 (34.8)	218,190 (34.0)	234,820 (33.6)	251,421 (33)	262,768 (32.1)	275,372 (31.3)	285,694 (30.4)	< 0.001
65 to < 75 years	128,653 (29.4)	137,522 (28.4)	147,199 (27.5)	155,224 (26.4)	162,464 (25.3)	174,412 (24.9)	190,419 (25.0)	209,199 (25.5)	227,509 (25.9)	242,156 (25.8)	< 0.001
≥ 75 years	152,950 (34.9)	176,234 (36.4)	200,523 (37.5)	228,040 (38.8)	260,497 (40.6)	290,084 (41.5)	320,101 (42.0)	347,695 (42.4)	376,272 (42.8)	412,213 (43.9)	< 0.001
Men	237,632 (54.3)	263,218 (54.4)	290,750 (54.4)	319,823 (54.4)	349,381 (54.5)	381,861 (54.6)	417,009 (54.7)	449,253 (54.8)	482,553 (54.9)	516,477 (54.9)	< 0.001
Comorbidities											
Hypertension	361,736 (82.6)	395,053 (81.6)	433,552 (81.1)	475,517 (80.9)	517,024 (80.6)	562,724 (80.5)	613,548 (80.5)	659,694 (80.5)	707,187 (80.4)	756,345 (80.5)	< 0.001
Diabetes	118,050 (27.0)	131,536 (27.2)	145,773 (27.3)	162,068 (27.56)	179,464 (28.0)	198,619 (28.4)	220,901 (29.0)	243,078 (29.7)	267,726 (30.6)	295,798 (31.5)	< 0.001
Heart failure	71,473 (16.3)	78,654 (16.2)	88,850 (16.6)	113,413 (19.3)	141,450 (22.1)	172,034 (24.6)	201,489 (26.4)	219,171 (26.7)	236,929 (27.0)	259,598 (27.6)	< 0.001
Prior ischemic stroke	65,535 (15.0)	78,422 (16.2)	91,329 (17.1)	105,628 (18.0)	119,959 (18.7)	135,373 (19.4)	151,960 (19.9)	167,036 (20.4)	181,545 (20.7)	196,544 (20.9)	< 0.001
Prior TIA	5165 (1.2)	6403 (1.3)	7609 (1.4)	9180 (1.6)	10,525 (1.6)	12,099 (1.7)	14,095 (1.9)	16,230 (2.0)	18,170 (2.1)	20,050 (2.1)	< 0.001
Vascular disease	58,098 (13.3)	60,875 (12.6)	67,642 (12.7)	76,987 (13.1)	87,623 (13.7)	100,462 (14.4)	114,823 (15.1)	124,307 (15.2)	135,910 (15.5)	148,562 (15.8)	< 0.001
MI	39,547 (9.0)	39,914 (8.2)	44,095 (8.3)	49,775 (8.5)	56,713 (8.9)	66,342 (9.5)	77,181 (10.1)	84,765 (10.3)	94,029 (10.7)	104,144 (11.1)	< 0.001
PAD	21,068 (4.8)	23,533 (4.9)	26,474 (5.0)	30.688 (5.2)	3.5050 (5.5)	39,180 (5.6)	43,674 (5.7)	45,982 (5.6)	48,956 (5.6)	52,102 (5.5)	< 0.001
CHA_2DS_2-VASc	3.2 ± 1.8	3.2 ± 1.9	3.2 ± 1.9	3.3 ± 1.9	3.4 ± 1.9	3.4 ± 2	3.5 ± 2	3.5 ± 2	3.5 ± 2	3.6 ± 2	< 0.001
0	22,120 (5.1)	25,680 (5.3)	28,880 (5.4)	31,364 (5.3)	33,666 (5.3)	35,930 (5.1)	37,941 (5.0)	39,723 (4.9)	41,339 (4.7)	42,825 (4.6)	< 0.001
1	67,069 (15.3)	73,665 (15.2)	80,497 (15.1)	86,101 (14.7)	89,954 (14.0)	94,818 (13.6)	99,444 (13.1)	103,863 (12.7)	108,597 (12.4)	112,088 (11.9)	< 0.001
2	83,438 (19.1)	88,700 (18.3)	95,037 (17.8)	101,043 (17.2)	106,292 (16.6)	113,011 (16.2)	120,754 (15.9)	127,761 (15.6)	135,353 (15.4)	141,957 (15.1)	< 0.001
3	86,975 (19.9)	94,626 (19.54)	102,889 (19.25)	110,959 (18.88)	118,270 (18.45)	127,169 (18.18)	137,321 (18.02)	148,140 (18.07)	159,013 (18.1)	169,210 (18.0)	< 0.001
4	78,908 (18.0)	87,485 (18.07)	96,343 (18.03)	105,454 (17.94)	116,000 (18.1)	126,357 (18.07)	137,952 (18.1)	150,241 (18.3)	162,414 (18.5)	174,928 (18.6)	< 0.001
5	50,359 (11.5)	57,005 (11.8)	64,690 (12.1)	73,848 (12.6)	83,635 (13.0)	93,558 (13.4)	104,517 (13.7)	113,293 (13.8)	123,196 (14.0)	133,659 (14.2)	< 0.001
6	28,673 (6.6)	33,637 (7.0)	38,701 (7.2)	45,388 (7.7)	52,304 (8.2)	60,005 (8.6)	67,789 (8.9)	74,609 (9.1)	81,291 (9.3)	89,069 (9.5)	< 0.001
7	14,491 (3.3)	16,808 (3.5)	19,714 (3.7)	23,668 (4.0)	28,507 (4.5)	33,071 (4.7)	38,134 (5)	41,886 (5.1)	45,741 (5.2)	51,209 (5.5)	< 0.001
8	4847 (1.1)	5606 (1.2)	6593 (1.2)	8451 (1.4)	10,660 (1.7)	13,007 (1.9)	15,157 (2.0)	16,964 (2.1)	18,663 (2.1)	21,023 (2.24)	< 0.001
9	889 (0.2)	977 (0.2)	1,115 (0.2)	1,476 (0.3)	1,863 (0.3)	2,390 (0.3)	2,932 (0.4)	3,182 (0.4)	3,546 (0.4)	4,095 (0.4)	< 0.001

Continuous variables are presented as mean ± SD and categorical variables are presented as number and percentage

Abbreviations: MI, myocardial infarction; PAD, peripheral artery disease; SD, standard deviation; TIA, transient ischemic attack

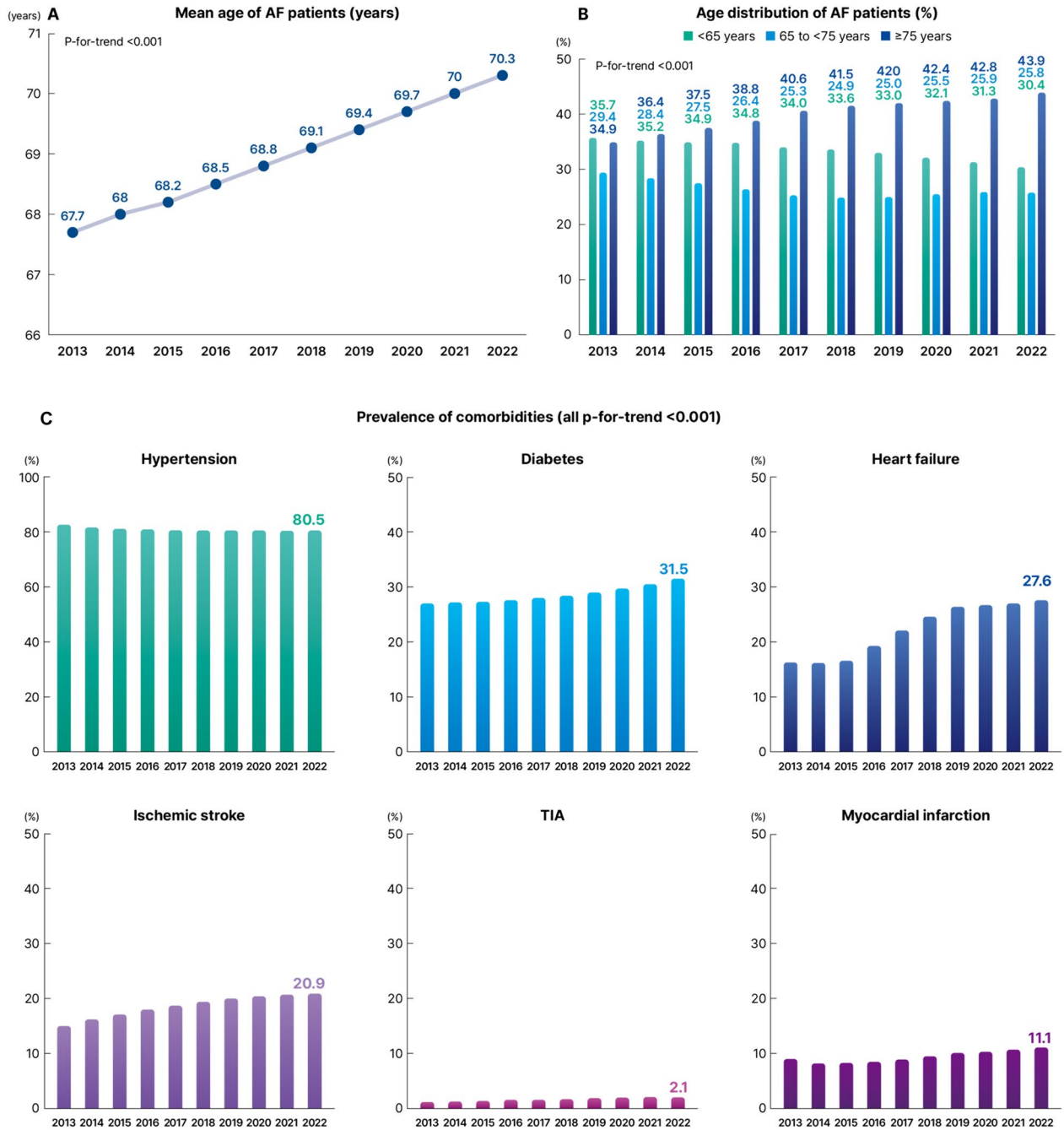

Fig. 5 Trends of risk profiles in patients with prevalent atrial fibrillation. **A** Mean age of patients with prevalent atrial fibrillation from 2013 to 2022. **B** Age distribution changes of patients with prevalent atrial fibrillation from 2013 to 2022. **C** Changes in prevalence of comorbidities in patients with prevalent atrial fibrillation from 2013 to 2022. Abbreviation: AF, atrial fibrillation; TIA, transient ischemic attack

The incidence of AF in Korea continues to rise, with a sharp increase observed among older adults. Although the overall incidence was lower in Korea than in Europe and the USA, where US-based cohort studies reported incidence rates ranging from 3.3 to 19.2 per 1000 person-years [7, 32] and the Rotterdam study enrolling

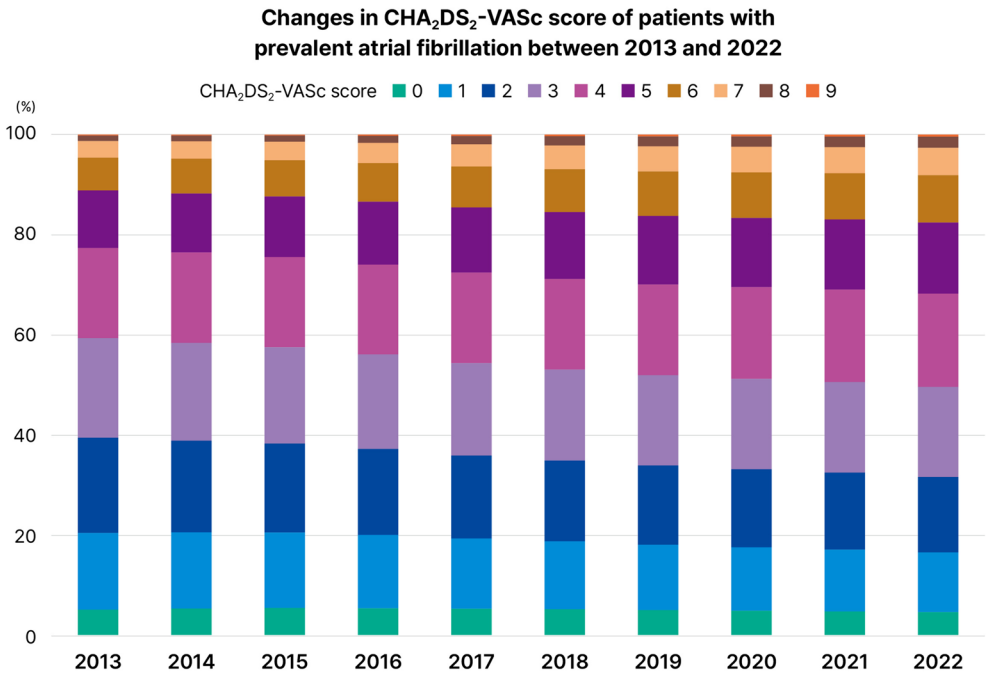

Fig. 6 Changes in CHA_2DS_2-VASc score of patients with prevalent atrial fibrillation between 2013 and 2022

participants aged ≥ 55 years found an AF incidence rate of approximately 9.9 per 1000 person-years [33], our findings were comparable to those in the Chinese population with an incidence of 1.51 per 1000 person-years in 2011.

The characteristics of patients with prevalent AF are becoming increasingly high-risk due to advancing age and more comorbidities. The proportion of patients with AF with CHA_2DS_2-VASc scores of ≥ 2 steadily increased between 2013 and 2022. By 2022, 43.9% of patients with prevalent AF were at least 75 years old, and 93.5% were high-risk for stroke (CHA_2DS_2-VASc score of ≥ 2). Hypertension, diabetes, and HF are common comorbidities among patients with AF, with hypertension being the most frequent. Large epidemiological studies showed that approximately 70% of patients with AF have hypertension, and approximately 20% have diabetes, consistent with our findings [34]. HF has been reported in 8–58% of the AF population. [35] Our results indicate that the increasing prevalence of comorbidities with age significantly influences the distribution of CHA_2DS_2-VASc scores, thereby affecting stroke risk. Given these changes, it is crucial to develop updated anticoagulation strategies [36] and comorbidity management plans, such as the ABC pathway and HEAD2TOES scheme [37, 38].

Study limitations

This study has some limitations due to the nature of the nationwide registry dataset used. Studies utilizing administrative databases can be prone to coding inaccuracies. Since AF cases were defined solely using ICD-10 codes, paroxysmal or asymptomatic AF cases not identified by these codes might have been omitted. However, a previous study has reported the validation of this operational definition of AF in 628 randomly selected patients, revealing a 94.1% positive predictive value [20]. Additionally, we were unable to analyze paroxysmal, persistent, and permanent AF subgroups separately. This study included only Korean patients, and the results may not be generalizable to other populations. Despite these limitations, this study analyzed longitudinal data from the entire Korean adult population, offering insights into the "real-world" AF burden on a national scale.

Table 2 Characteristics for each year of the 458,666 patients with atrial fibrillation as of 2017 who survived to 2022

	2017	2018	2019	2020	2021	2022	P for trend
Age (years)	65.1 ± 13.4	66.1 ± 13.4	67.1 ± 13.4	68.1 ± 13.4	69.1 ± 13.4	70.1 ± 13.4	< 0.001
< 65 years	200,436 (43.7)	188,904 (41.2)	176,621 (38.5)	163,680 (35.7)	151,924 (33.1)	140,261 (30.6)	< 0.001
65 to < 75 years	131,043 (28.6)	128,832 (28.1)	127,833 (27.9)	128,643 (28.1)	127,786 (27.9)	124,432 (27.1)	< 0.001
≥ 75 years	127,187 (27.7)	140,930 (30.7)	154,212 (33.6)	166,343 (36.3)	178,956 (39.0)	193,973 (42.3)	< 0.001
Men	255,487 (55.7)	255,487 (55.7)	255,487 (55.7)	255,487 (55.7)	255,487 (55.7)	255,487 (55.7)	< 0.001
Comorbidities							
Hypertension	354,213 (77.2)	356,522 (77.7)	358,092 (78.1)	358,126 (78.1)	358,095 (78.1)	360,228 (78.5)	< 0.001
Diabetes	110,825 (24.2)	115,892 (25.3)	121,476 (26.5)	126,532 (27.6)	132,045 (28.8)	139,111 (30.3)	< 0.001
Heart failure	69,132 (15.1)	78,761 (17.2)	86,640 (18.9)	86,757 (18.9)	85,222 (18.6)	91,922 (20.0)	< 0.001
Prior ischemic stroke	60,877 (13.3)	66,526 (14.5)	72,411 (15.8)	77,732 (17.0)	83,235 (18.2)	89,476 (19.5)	< 0.001
Prior TIA	6609 (1.4)	7086 (1.5)	7596 (1.7)	7993 (1.7)	8419 (1.8)	8799 (1.9)	< 0.001
Vascular disease	53,113 (11.6)	55,458 (12.1)	57,461 (12.5)	56,821 (12.4)	56,759 (12.4)	58,644 (12.8)	< 0.001
MI	32,431 (7.1)	34,253 (7.47)	35,948 (7.8)	35,837 (7.8)	36,020 (7.9)	37,922 (8.3)	< 0.001
PAD	22,783 (5.0)	23,600 (5.15)	24,111 (5.3)	23,556 (5.1)	23,366 (5.1)	23,418 (5.1)	< 0.001
CHA_2DS_2-VASc	2.9 ± 1.8	3 ± 1.8	3.1 ± 1.8	3.2 ± 1.9	3.3 ± 1.9	3.4 ± 1.9	< 0.001
0	32,200 (7.0)	30,255 (6.6)	28,540 (6.2)	27,417 (5.98)	26,225 (5.7)	24,433 (5.3)	< 0.001
1	84,691 (18.5)	78,818 (17.2)	73,243 (16.0)	68,772 (14.99)	64,742 (14.1)	59,632 (13.0)	< 0.001
2	93,433 (20.4)	88,801 (19.4)	84,624 (18.6)	80,911 (17.64)	77,442 (16.9)	73,446 (16.0)	< 0.001
3	91,264 (19.9)	90,686 (19.8)	89,344 (19.5)	89,012 (19.4)	88,567 (19.3)	87,086 (19.0)	< 0.001
4	76,007 (16.6)	78,792 (17.2)	81,247 (17.7)	83,702 (18.3)	85,483 (18.6)	86,771 (18.9)	< 0.001
5	45,107 (9.8)	48,844 (10.7)	52,590 (11.5)	55,171 (12.0)	57,632 (12.6)	60,846 (13.3)	< 0.001
6	22,909 (5.0)	26,301 (5.7)	29,606 (6.5)	31,891 (7.0)	34,446 (7.5)	37,894 (8.3)	< 0.001
7	9,797 (2.1)	11,843 (2.6)	14,004 (3.1)	15,540 (3.4)	17,161 (3.74)	20,071 (4.4)	< 0.001
8	2,814 (0.6)	3,703 (0.8)	4,666 (1.0)	5,361 (1.17)	5,974 (1.3)	7,240 (1.6)	< 0.001
9	444 (0.1)	623 (0.1)	802 (0.2)	889 (0.19)	994 (0.2)	1,247 (0.3)	< 0.001

Continuous variables are presented as mean ± SD and categorical variables are presented as number and percentage

Abbreviations: MI, myocardial infarction; PAD, peripheral artery disease; SD, standard deviation; TIA, transient ischemic attack

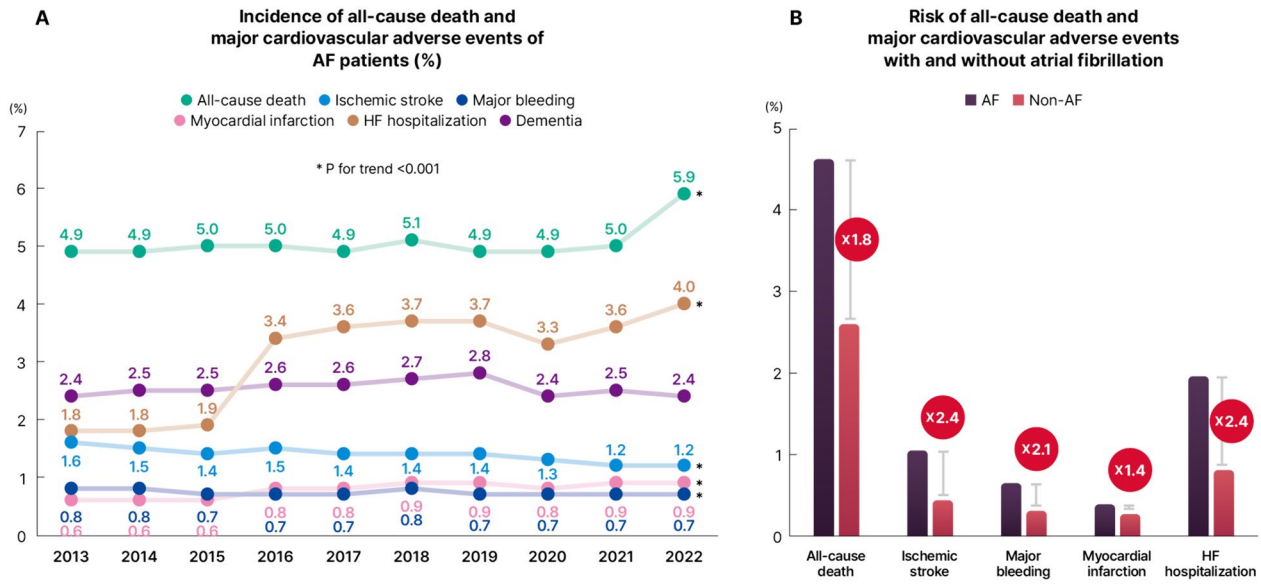

Fig. 7 Clinical outcomes of patients with prevalent atrial fibrillation. **A** Incidence of all-cause death and major cardiovascular adverse events of patients with atrial fibrillation. **B** Risk of all-cause death and major cardiovascular adverse events with and without atrial fibrillation. Abbreviation: AF, atrial fibrillation; HF, heart failure

Conclusion

The prevalence and incidence of AF have steadily increased between 2013 and 2022, with the increase being more pronounced in older patients. Patients with AF are increasingly becoming a high-risk population and are at increased risk of clinical adverse outcomes compared to non-AF patients. Based on this data, a sustained national effort to improve awareness of AF and the quality of comprehensive care for patients with AF is required.

Supplementary Information

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Supplementary Material 1.

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Author contributions
E-KC contributed to the conception and design of the work and critical revision of the manuscript. S-RL and DK contributed to the interpretation of data and drafting of the manuscript. SHL, W-HL, KJC, and W-SC contributed to the conception and design of the work and the revision of the manuscript. H-JA, K-YL, and JMC contributed to the acquisition of data for the work. B-SK and K-DH contributed to the analysis of data for the work.

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Availability of data and materials
The data underlying this article are available in the National Health Insurance Sharing Service of Korea at https://nhiss.nhis.or.kr. Applications to use the data will be reviewed by the inquiry committee of research support and, once approved, raw data will be provided to the authorized researcher with a fee at several permitted sites.

Declarations

Ethics approval and consent to participate
This study was approved by the Institutional Review Board of Seoul National University Hospital (E-2306-004-1435), The requirement for informed consent was waived because personal identification information was removed after cohort generation, in accordance with the strict confidentiality guidelines.

Competing interests
EKC: Research grants or speaking fees from Abbott, Bayer, BMS/Pfizer, Biosense Webster, Chong Kun Dang, Daewoong Pharmaceutical Co., Daiichi-Sankyo, DeepQure, Dreamtech Co., Ltd., Jeil Pharmaceutical Co. Ltd, Medtronic, Samjinpharm, Samsung Electronics Co., Ltd., Seers Technology, and Skylabs.

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