Worldwide Epidemiology of Atrial Fibrillation
A Global Burden of Disease 2010 Study

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Background—The global burden of atrial fibrillation (AF) is unknown.

Methods and Results—We systematically reviewed population-based studies of AF published from 1980 to 2010 from the 21 Global Burden of Disease regions to estimate global/regional prevalence, incidence, and morbidity and mortality related to AF (DisModMR software). Of 377 potential studies identified, 184 met prespecified eligibility criteria. The estimated number of individuals with AF globally in 2010 was 33.5 million (20.9 million men [95% uncertainty interval (UI), 19.5–22.2 million] and 12.6 million women [95% UI, 12.0–13.7 million]). Burden associated with AF, measured as disability-adjusted life-years, increased by 18.8% (95% UI, 15.8–19.3) in men and 18.9% (95% UI, 15.8–23.5) in women from 1990 to 2010. In 1990, the estimated age-adjusted prevalence rates of AF (per 100 000 population) were 569.5 in men (95% UI, 532.8–612.7) and 359.9 in women (95% UI, 334.7–392.6); the estimated age-adjusted incidence rates were 60.7 per 100 000 person-years in men (95% UI, 49.2–78.5) and 43.8 in women (95% UI, 35.9–55.0). In 2010, the prevalence rates increased to 596.2 (95% UI, 558.4–636.7) in men and 373.1 (95% UI, 347.9–402.2) in women; the incidence rates increased to 77.5 (95% UI, 65.2–95.4) in men and 59.5 (95% UI, 49.9–74.9) in women. Mortality associated with AF was higher in women and increased by 2-fold (95% UI, 2.0–2.2) and 1.9-fold (95% UI, 1.8–2.0) in men and women, respectively, from 1990 to 2010. There was evidence of significant regional heterogeneity in AF estimations and availability of population-based data.

Conclusions—These findings provide evidence of progressive increases in overall burden, incidence, prevalence, and AF-associated mortality between 1990 and 2010, with significant public health implications. Systematic, regional surveillance of AF is required to better direct prevention and treatment strategies. **(*Circulation*. 2014;129:837-847.)**

Key Words: atrial fibrillation ■ epidemiology ■ incidence ■ prevalence ■ risk factors, prevention

Atrial fibrillation (AF) is the most common arrhythmia of clinical significance.[1] In adjusted models, AF is associated with increased morbidity, especially stroke and heart failure, and increased mortality.[2–5] AF constitutes a significant public health problem, and estimates suggest that this condition accounts for 1% of the National Health Service budget in the United Kingdom[6] and $16 to 26 billion of annual US expenses.[7,8]

Editorial see p 829
Clinical Perspective on p 847

Several regional studies suggest a rising prevalence and incidence of AF.[9–13] These secular trends may be explained in part by the demographic transition to an inverted age pyramid because frequency of AF increases with advancing age. Others have demonstrated an increase in AF incidence after age adjustment, which is probably a reflection of comorbidities and cardiovascular risk factors, in addition to other factors such as lifestyle changes.[14,15] In the United States, it is estimated that the number of adults with AF will more than double by the year 2050;[16] even higher increases have been predicted.[14]

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In view of the emergence of AF as a growing epidemic,[15,17] an assessment of the global burden of AF is warranted. We therefore conducted a comparative assessment of the burden of AF across defined time periods based on available epidemiological data from the 21 Global Burden of Disease (GBD) regions.

Methods

The GBD Study

Our analysis was performed within the framework of the latest Global Burden of Disease, Injuries, and Risk Factors Study (GBD 2010 Study).[18] The GBD 2010 Study is a collaborative effort led by a consortium that includes Harvard University, the Institute for Health Metrics and Evaluation at the University of Washington, Johns Hopkins University, the University of Queensland, the University of Tokyo, Imperial College London, and the World Health Organization. It follows on the original GBD 1990 Study commissioned by the World Bank in 1991 and aims to systematically assess global data on all diseases and injuries. GBD 2010 provides a common instrument for assessing mortality and morbidity. The goal was to provide comparable estimates at different time periods with analysis of secular trends. Detailed information about the data, techniques, and methods for estimation of different disease parameters has been published elsewhere.[19–21]

Search Strategy and Data Sources

As a subcommittee of the GBD 2010 Committee on Cardiovascular Disease and following the GBD 2010 protocol, the GBD Arrhythmias Panel performed a systematic review of the available literature (Appendix I in the online-only Data Supplement) to identify epidemiological studies of AF (1980–2010) that were population based. For the initial identification of published studies, we used the following search terms: atrial fibrillation, atrial flutter, epidemiology, incidence, prevalence, mortality, and case fatality rate. MEDLINE, EMBASE, and LILACS were queried for studies published between 1980 and 2010 (for LILACS, the time period was 1982–2010). There were no restrictions based on language of publication. Details of the search are outlined in Appendix II in the online-only Data Supplement. The initial search (phase 1) generated abstracts that were reviewed (phase 2) on the basis of prespecified inclusion and exclusion criteria (Appendix III in the online-only Data Supplement). Whereas all studies on AF epidemiology in the general population were included, studies conducted on selected clinical subgroups such as inpatients or those with heart failure were excluded to arrive at accurate estimates of AF burden at a population-wide level. The selected abstracts underwent full text reviews (phase 3) to confirm eligibility, generating a final list of publications selected for abstraction. Each publication was assigned to 1 of 21 epidemiological regions as designated in GBD 2005. To minimize potential bias resulting from inconsistent case definitions of AF, all published studies of paroxysmal, persistent, or permanent/chronic AF and atrial flutter were included.

Statistical Methods

Incidence rate was defined as the annual number of new cases with AF divided by the population at midyear. Prevalence rate was defined as the overall number of cases with the total population as denominator. Prevalence and incidence rates were age adjusted. Rates were presented per 100 000 persons or person-years with 95% uncertainty intervals (UIs). The denominators were derived from the United Nations population database (http://www.un.org/esa/population/), and classifications of countries, regions, and groups (eg, developed and developing countries) followed the definitions of the World Bank (http://data.worldbank.org/about/country-classifications) and GBD core team decisions.[22]

Modeling of AF as a Cause of Death

Mortality associated with AF was estimated by use of an integrated method, with information on several country-level covariates used to inform the analysis.[19] All combinations of the covariates with a significant coefficient ($P<0.05$) and expected direction of the effect were used to estimate the number of deaths. The performance of each model in terms of external validity was evaluated and constituted the final ensemble model estimate. External validity criteria were used to rank all models and to produce ensemble results.[23] The covariates and external validity of the ensemble model are reported in Appendix IV (Tables I and II in the online-only Data Supplement). In the next step, each individual cause of death was adjusted to obtain overall cardiovascular mortality (CoDCorrect process).[19] The GBD method provides the mortality rate attributable to AF as opposed to total case fatality rate in AF patients.

Modeling of Morbidity Associated With AF

We used incidence, prevalence, excess mortality, and AF mortality rate (estimated by the CODEm process) in a bayesian meta-regression tool (DisMod-MR: Figure 1).[21,24] DisMod-MR estimates a generalized negative binomial model for all the epidemiological data with fixed and random effects. Data modeled with fixed effects include age, covariates that predict country variation in the quantity of interest, variation across studies resulting from attributes of the study protocol, and random effects of super-region, region, and country. DisMod-MR can be used to estimate age-, sex-, and country-specific prevalence from heterogeneous and often sparse data sets. We used

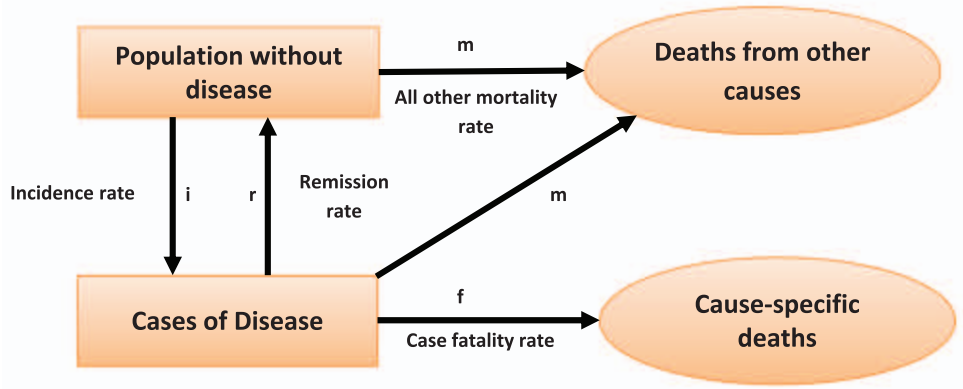

Figure 1. Conceptual disease model. Flow chart illustrating the conceptual disease model used (DisMod-MR software). The model includes the number of people without the disease (atrial fibrillation in this case), the number of people with the disease, the number of deaths associated with the disease, and the number of deaths resulting from all other causes. The transitions between these states are represented by incidence (i), remission (m), case fatality (f), and all other mortality (m). In the case of atrial fibrillation, remission was assumed to be zero. (Modified from Barendregt et al.[24] Copyright © 2003 Barendregt et al; licensee BioMed Central Ltd.)

DisMod to estimate the total number of patients living with AF. The history of at least 1 confirmed AF episode is the common definition of AF used in prevalence studies. We used this definition in the modeling and estimation of different epidemiological parameters such as prevalence, incidence, and case fatality (excess mortality rate).[21]

As for all conditions assessed in the GBD project, burden associated with AF was measured as disability-adjusted life-years (DALYs). The DALY metric was introduced in the original GBD 1990 study as a means of assessing the disability of chronic disorders.[22] DALYs combine information on premature death (years of life lost) and disability caused by the condition (years lived with disability). One DALY corresponds to 1 lost year of health and is calculated as years of life lost plus years lived with disability. As previously described in detail,[25,26] years lived with disability are calculated by multiplying the estimated number of incident cases by the average duration of the disease and a disability weight factor (range, 0–1, where 0 is total health and 1 is total disability). Disability weights for sequelae of multiple disease conditions were estimated by 4 population-based surveys in Bangladesh, Indonesia, Peru, and Tanzania; a telephone survey in the United States; and an open-access Web-based survey.[27] AF sequelae were defined as "daily medication and at least minimal interference with daily activities" and accordingly assigned a disability weight of 0.031.

Role of the Funding Source

The funding sources had no influence over the study, the interpretation of the results, writing of the manuscript, or decision to submit for publication. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Results

Data Availability

The initial search generated 4574 abstracts (Appendix I in the online-only Data Supplement). Of these, 377 published studies (8.2%) were identified as meeting initial criteria. After a full text review, 193 studies were excluded (ie, did not meet the prespecified quality measures), and the remaining184 studies moved to the abstraction stage. The majority of studies were from Western Europe and North America (35.9% and 35.6% of included data sources, respectively).

Prevalence of AF

Table 1 shows the estimated age-adjusted AF prevalence rates stratified by sex (Figure 2; complete data for all GBD regions are given in Table Ia and Ib in the online-only Data Supplement). In 1990, the estimated global prevalence rates (per 100 000 population) were 569.5 (95% UI, 532.8–612.7) in men and 359.9 (95% UI, 334.7–392.6) in women. In 2010, prevalence rates were 596.2 (95% UI, 558.4–636.7) in men and 373.1 (95% UI, 347.9–402.2) in women. The prevalence rates showed a modest increase between 1990 and 2010 (Figure 3) across both sexes. Developed countries had higher prevalence rates compared with developing countries; however, this difference was more pronounced in men than in women. For all time points, the prevalence was higher in men compared with women. There was significant variation in prevalence between GBD regions. The lowest prevalence rates (2010) were estimated in the Asia-Pacific region for both men and women (340.2 and 196.0, respectively). The highest rates were estimated in North America (925.7 for men and 520.8 for women). The prevalence and incidence for Sub- Saharan Africa were lower compared with a developed region such as North America. Overall, for the Sub-Saharan Africa super-region, in 2010, the prevalence of AF (age-adjusted, per 100 000 population) was 659.8 (95% UI, 511.0–850.4) for men and 438.1 (95% UI, 340.2–561.0) for women. The median change in prevalence was higher in developed countries, with the largest increase noted in North America (40.1%) and the least change in Sub-Saharan Africa, East (3.4%; Table II in the online-only Data Supplement). Prevalence rates increased significantly with increasing age (Figures IA and IB in the online-only Data Supplement), with rates in the ≥35-year-old population observed to be more than double the overall prevalence. With the DisMod MR-estimated prevalence rates applied to the world population of 2010, the estimated number of individuals with AF globally is 20.9 million men (95% UI, 19.5–22.2 million) and 12.6 million women (95% UI, 12.0–13.7 million).

Incidence of AF

Table 2 shows the estimated age-adjusted incidence rates of AF stratified by sex (complete data for all GBD regions are given in Table IIIa and IIIb in the online-only Data Supplement). In 1990, the overall incidence rates of the world population were 60.7 (95% UI, 49.2–78.5) per 100 000 person-years in men and 43.8 (95% UI, 35.9–55.0) in women. In 2010, the estimated incidence rates were higher, 77.5 (95% UI, 65.2–95.4) in men and 59.5 (95% UI, 49.9–74.9)

Table 1. Estimated Age-Adjusted Prevalence Rates With 95% Uncertainty Intervals of Atrial Fibrillation (per 100 000 Population) for Men and Women

	1990	1995	2000	2005	2010
Men					
Global, all ages	569.5 (532.8–612.7)	578.1 (541.2–620.9)	586.8 (549.8–629.5)	595.1 (557.3–639.0)	596.2 (558.4–636.7)
Age ≥35 y	1307.4 (1222.5–1407.3)	1327.3 (1243.2–1425.7)	1347.6 (1263.4–1445.8)	1366.6 (1281.0–1467.1)	1368.5 (1280.8–1462.7)
Developed countries	608.2 (547·0–693.5)	625.6 (564.0–712.5)	643.1 (580.3–730.2)	660.0 (594.5–740.8)	660.9 (597.1–738.2)
Developing countries	546.6 (503.0–599.6)	551.1 (506.6–604.8)	555.8 (511.0–610.1)	561.3 (517.5–618.4)	565.7 (522.9–617.6)
Women					
Global, all ages	359.9 (334.7–392.6)	363.4 (338.5–395.3)	366.7 (342.0–397.8)	369.6 (345.5–399.9)	373.1 (347.9–402.2)
Age ≥35 y	826.5 (768.4–902.3)	834.7 (776.6–909.2)	842.3 (784.7–915.5)	849.0 (792.4–919.6)	856.8 (797.7–923.5)
Developed countries	362.5 (319.3–422.3)	370.1 (326.7–429.5)	377.5 (334.0–436.8)	385.1 (340.1–446.8)	387.7 (343.8–450.0)
Developing countries	358.2 (329.8–393.0)	359.0 (330.8–394.0)	359·8 (331.5–395.0)	360.9 (331.6–396.0)	366.1 (337.4–400.8)

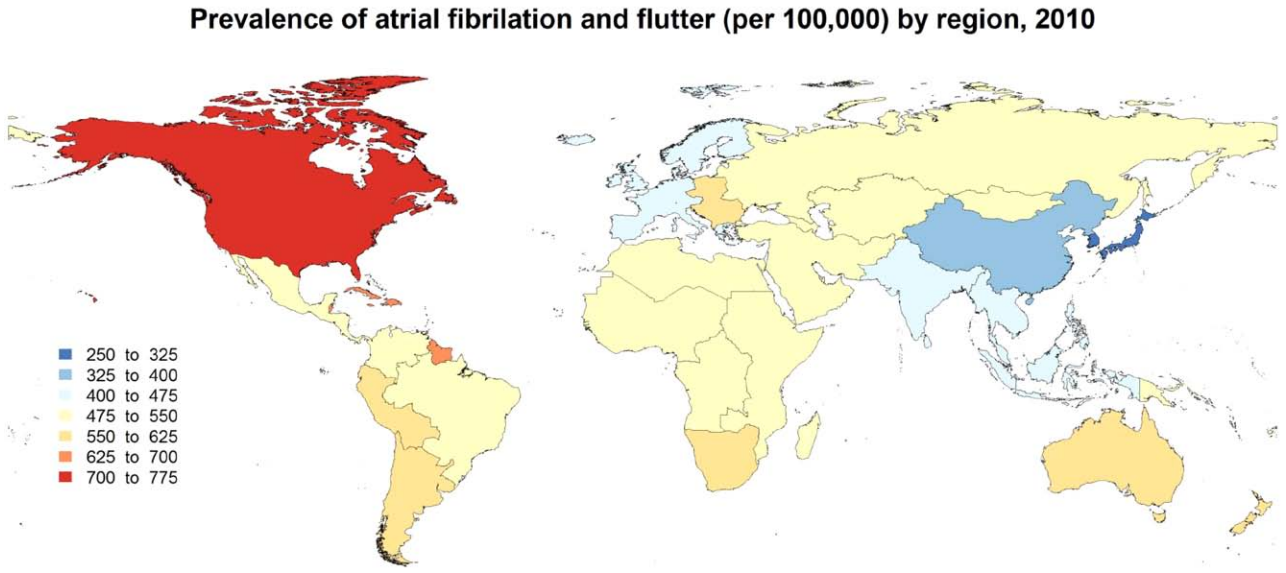

Figure 2. World map showing the age-adjusted prevalence rates (per 100 000 population) of atrial fibrillation in the 21 Global Burden of Disease regions, 2010.

in women, as shown in Figure 4. There were significantly higher (≈2-fold) incidence rates in developed regions compared with developing countries. For both time periods, similar to the observations for prevalence, AF incidence rates were higher in men compared with women. Again, there was great variation between GBD regions. The lowest incidence rates (2010) were estimated in the Asia-Pacific region for both men and women (33.8 and 19.8, respectively). The highest rates were estimated in North America (264.5 for men and 196.3 for women). As for prevalence, the incidence rates were also lower in the Sub-Saharan region, reported as 58.4 (95% UI, 43.7–78.5) and 42.7 (95% UI, 31.1–60.5) in men and women, respectively. Incidence rates were also higher in the older age groups (Figure IIA and IIB in the online-only Data Supplement).

When the estimated incidence rates are applied to the world population of 2010, the estimated number of new AF cases per year is 2.7 million (95% UI, 2.3–3.3 million) for men and 2.0 million (95% UI, 1.7–2.6 million) for women.

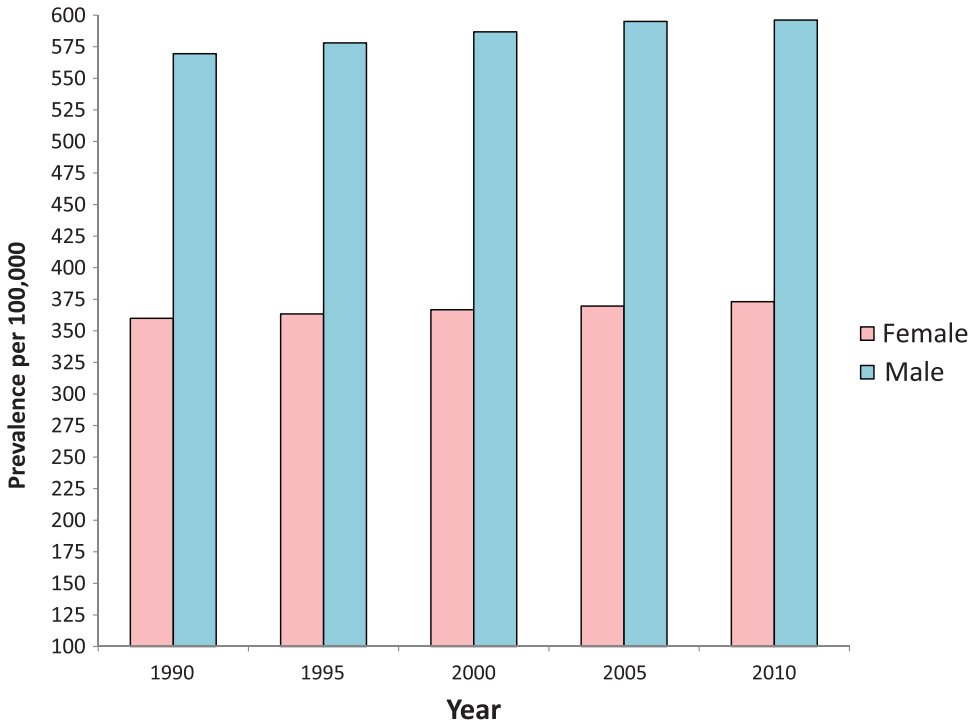

Figure 3. Prevalence of atrial fibrillation: 1990 to 2010. Estimated age-adjusted global prevalence of atrial fibrillation (per 100 000 population) for men and women from 1990 to 2010.

Table 2. Estimated Age-Adjusted Incidence Rates with 95% Uncertainty Intervals of Atrial Fibrillation (per 100 000 Person-years) for Men and Women

	1990	2010
Men		
Global, all ages	60.7 (49.2–78.5)	77.5 (65.2–95.4)
Age ≥35 y	141.0 (114.6–182.6)	181.2 (152.6–222.8)
Developed countries	78.4 (67.5–91.9)	123.4 (107.6–141.5)
Developing countries	50.0 (33.8–76.8)	53.8 (38.7–79.8)
Women		
Global, all ages	43.8 (35.9–55.0)	59.5 (49.9–74.9)
Age ≥35 y	102.0 (83.9–127.9)	139.7 (117.1–175.3)
Developed countries	52.8 (45.0–62.9)	90.4 (77.8–104.5)
Developing countries	36.0 (24.5–54.7)	40.0 (27.2–62.6)

Mortality and Disease Burden Associated With AF

The age-adjusted mortality rate (per 100 000 population) for AF in 1990 was 0.8 (95% UI, 0.5–1.1) for men and 0.9 (95% UI, 0.7–1.2) for women. The age-adjusted mortality rate increased to 1.6 (95% UI, 1.0–2.4) and 1.7 (95% UI, 1.4–2.2) in 2010, representing 2-fold (95% UI, 2.0–2.2) and 1.9-fold (95% UI, 1.8–2.0) increases, for men and women, respectively (Table 3; full data for all GBD regions are provided in Table IVa and IVb in the online-only Data Supplement). Mortality increased steadily through 1995, 2000, and 2005 (Figure 5), especially in the developed world. Mortality associated with AF was higher in women overall; this was driven mainly by comparatively higher mortality in women (compared with men) in developing countries (Figure 6). In 2010, the estimated numbers of total deaths (men and women) represented <1% of the global mortality in the vast majority of the 21 GBD regions (Figure 7).

The estimated age-adjusted DALYs (per 100 000 population) resulting from AF were 54.3 (95% UI, 39.2–72.7) and 38.6 (95% UI, 28.9–50.5) in 1990 for men and women, respectively. This number increased to 64.5 (95% UI, 46.8–84.2) and 45.9 (95% UI, 35.7–58.5) in 2010, representing increases of 18.8% (95% UI, 15.8–19.3) and 18.9% (95% UI, 15.8–23.5) for men and women, respectively (Table 4; complete data for all GBD regions are given in Table Va and Vb in the online-only Data Supplement; see Figure 8). In keeping with the higher incidence and prevalence of AF, DALYs were higher in developed compared with developing countries. The rate of change in DALYs was also higher in developed compared with developing countries (Table II in the online-only Data Supplement).

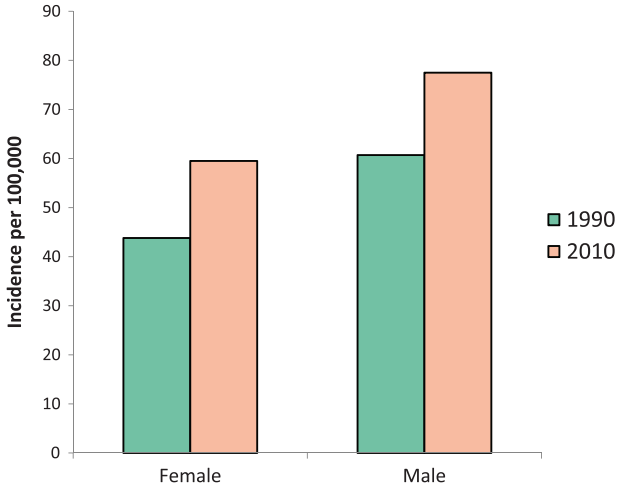

Figure 4. Incidence of atrial fibrillation: 1990 and 2010. Estimated age-adjusted global incidence (per 100 000 person-years) for men and women for 1990 and 2010.

Discussion

Our systematic review of the current worldwide epidemiological data on AF confirms the emergence of this condition as a global epidemic with significant and progressive effects on estimated disability and mortality. Furthermore, there were specific differences identified on the basis of age and GBD region that are likely to have significant implications for global public health.

As expected, higher rates of AF were observed in older age groups. For example, men 75 to 79 years of age have double the prevalence rate compared with men 65 to 69 years of age and >5-fold higher prevalence compared with men 55 to 59 years of age. The 2010 rates are higher than the 1990 rates, with increases in both prevalence and incidence rates in both sexes. Other regional studies have reported an increasing prevalence of AF, especially in the developed world. Piccini et al[13] reported a greater increase in the prevalence of AF (from 41.1 to 85.8 per 1000 between 1993 and 2007, with an annual rate of increase of ≈5%) compared with the present study, which is likely to be related to differences in the population studied, with the former study being restricted to elderly Medicare beneficiaries in the United States. The annual new cases of AF globally in 2010 were estimated at close to 5 million, which, together with the increasing trends observed, highlights the observation that the burden of AF is growing rapidly.

The exact reasons for these trends are unknown but may be partly explained by aging trends in the global population. One hypothesis for the increasing incidence is that AF in the majority of people is a vascular disease caused by hypertension, atherosclerosis, and other cardiovascular risk factors, which increase arterial stiffness and cause diastolic dysfunction and atrial volume overload, resulting in AF. Analysis of global risk factors in the GBD 2010 study showed that high blood pressure is the number 1 risk factor globally (increasing from the fourth position in 1990), accounting for 7% of all global DALYs. High body mass index ranks sixth in the global list, ascending from the 10th position in 1990. Deaths attributable to hypertension increased by 28.8% from 1990 to 2010, whereas deaths attributable to obesity increased by 71.7%.[18] Thus, it appears that the increase in AF burden potentially could be linked to risk factors such as hypertension and obesity at a global level. Although these alterations can be observed as part of the aging process, they are also likely to be involved independently of aging. Although a renewed focus on risk factors may help, other contributors to increasing AF incidence such as aging of the population, better survival from other disease conditions, and improved diagnosis also need to be acknowledged.

Temporal trends in AF prevalence may also result from lead time bias (such that AF cases may be diagnosed earlier in their

Table 3. Estimated Age-Adjusted Mortality Rates With 95% Uncertainty Intervals (per 100 000 Population) Associated With Atrial Fibrillation for Men and Women

	1990	1995	2000	2005	2010
Men					
Global, all ages	0.8 (0.5–1.1)	0.9 (0.6–1.3)	1.1 (0.7–1.5)	1.3 (0.8–1.8)	1.6 (1.0–2.4)
Age ≥35 y	1.9 (1.3–2.8)	2.2 (1.4–3.1)	2.7 (1.7–3.6)	3.2 (2.0–4.4)	3.8 (2.4–5.8)
Developed countries	1.3 (0.9–1.9)	1.6 (1.1–2.2)	2.0 (1.3–2.7)	2.3 (1.6–3.2)	2.7 (1.9–4.3)
Developing countries	0.4 (0.2–0.8)	0.4 (0.2–0.8)	0.5 (0.3–0.9)	0.6 (0.3–1.1)	0.7 (0.4–1.3)
Women					
Global, all ages	0.9 (0.7–1.2)	1.1 (0.9–1.4)	1.4 (1.2–1.8)	1.7 (1.4–2.1)	1.7 (1.4–2.2)
Age ≥35 y	2.2 (1.8–3.0)	2.7 (2.2–3.4)	3.5 (2.8–4.4)	4.0 (3.4–5.0)	4.2 (3.4–5.4)
Developed countries	1.1 (1.0–1.3)	1.4 (1.2–1.6)	1.9 (1.7–2.2)	2.3 (2.0–2.7)	2.4 (2.0–3.0)
Developing countries	0.7 (0.4–1.4)	0.8 (0.4–1.4)	0.9 (0.5–1.5)	0.9 (0.6–1.6)	1.0 (0.6–1.7)

course) and increased survival from coexistent cardiovascular conditions such as ischemic heart disease and heart failure. Improved management of these cardiovascular conditions may have resulted in a larger high-risk group. In addition, increased awareness of AF symptoms and clinical diagnosis likely play a role. Of interest, the change in AF prevalence from 2005 to 2010 was seen to be minimal, especially among men in the developed countries as opposed to developing countries. Although the exact reason for the leveling of prevalence rates is difficult to ascertain, one possibility may be an improved awareness and focus on management of risk factors in the developed world.

AF is known to have a significant impact on healthcare costs, with the major cost drivers being hospitalizations, stroke, and loss of productivity.[6,28,29] In the present study, AF was associated with <1% of all deaths in most World Health Organization regions. However, AF is known to coexist and interact with other conditions, contributing to a worse prognosis than for individuals without AF. For example, recent meta-analyses have shown that patients with heart failure and myocardial infarction have worse outcomes if they also have AF.[30,31] Moreover, new-onset AF in heart failure patients might be associated with a particularly poor prognosis.[32,33]

There were significant variations in the AF burden by GBD region, with developed countries having a greater burden overall. Recent reports indicate that a higher degree of European ancestry is associated with an increased predisposition to AF.[34] However, part of the global variation in AF epidemiology may also be attributable to better surveillance in developed countries. In the 1990 GBD study, no specific data for AF were reported, but cardiovascular diseases as a group accounted for 9.7% of the global DALYs, with ischemic heart disease being the fifth ranking disorder in total number of DALYS (≈47×10^6), behind lower respiratory infections, diarrheal diseases, perinatal disorders, and unipolar major depression.[35] In 2010, ischemic heart disease moved up to the number 1 position, with cardiovascular disease accounting for 11.8% of global DALYs. With the exception of Sub-Saharan Africa and Oceania, cardiovascular disease ranked among the top 3 causes of DALYs in most regions.[20] In keeping with these trends, DALYs related to AF increased by ≈18% from 1990 to 2010. Although the absolute DALYs related to AF (≈52 per 100 000 overall) are much lower compared with conditions such as chronic obstructive lung disease (1114 per 100 000), diabetes mellitus (680 per 100 000), and chronic kidney disease (307

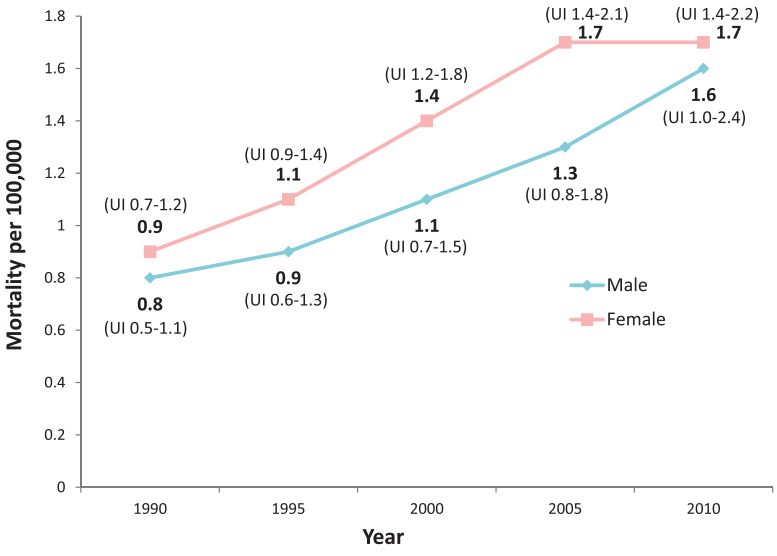

Figure 5. Mortality associated with atrial fibrillation: 1990 to 2010. Estimated age-adjusted mortality (per 100 000 population) associated with atrial fibrillation from 1990 to 2010. UI indicates uncertainty interval.

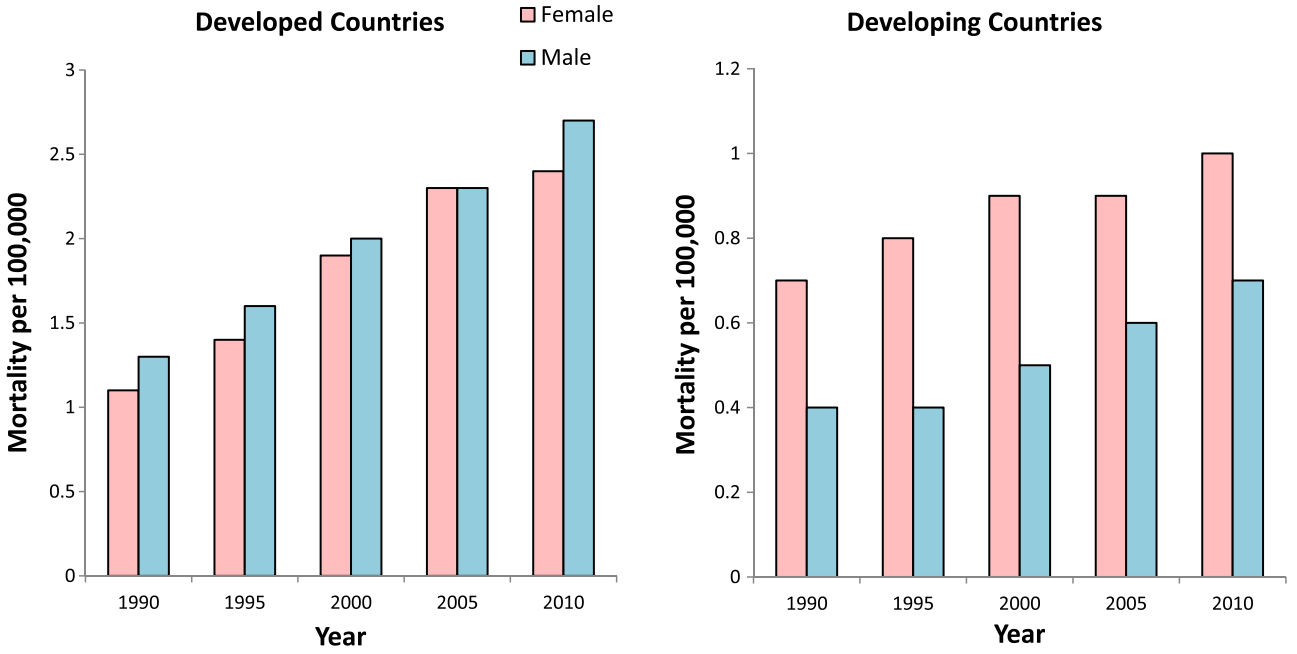

Figure 6. Mortality associated with atrial fibrillation (AF) stratified by sex and type of region (developed vs developing). Mortality associated with AF was higher in men and women in the developed regions. The significantly higher mortality in women in the developing regions is responsible for the overall higher AF-related mortality among women compared with men.

per 100 000),[20] as discussed earlier, AF can interact with other diseases in multiple ways, potentially contributing to worse outcomes. The rise of cardiovascular disease burden in developing countries possibly indicates an ongoing transition toward noncommunicable diseases, previously associated more with developed nations. Especially with current, rapidly evolving demographic changes in large population centers of the developing world, the effects of the rising global AF burden merit careful consideration with respect to distribution of dwindling healthcare resources. Additionally, there is an urgent need to design and deploy effective surveillance strategies for AF that will guide future World Health Organization region-specific prevention.

Limitations

Our study has several limitations. AF is a heterogeneous condition and in a subset of individuals can be asymptomatic.[36,37] Both features underscore the difficulties associated

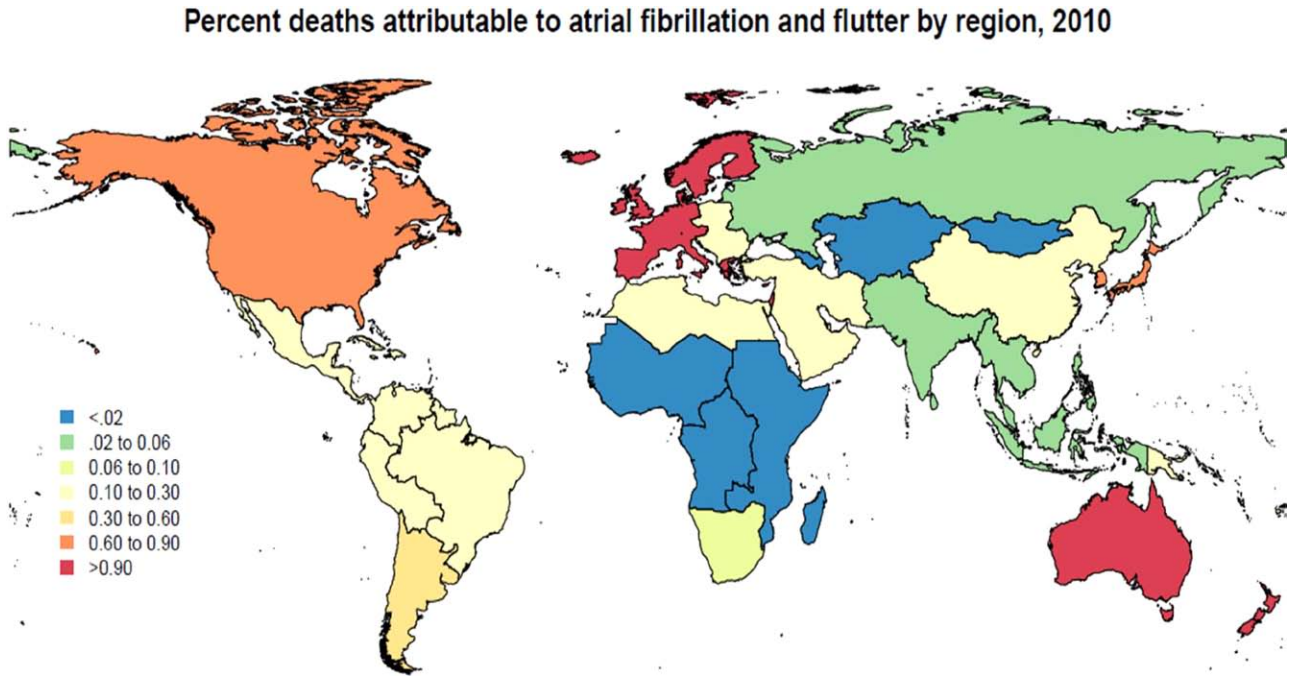

Figure 7. Proportion of global deaths associated with atrial fibrillation in 2010. The map shows color-coded proportions (in percentages) of global deaths in 2010 associated with atrial fibrillation.

Table 4. Estimated Age-Adjusted DALYs With 95% Uncertainty Intervals (per 100 000 Population) Associated With Atrial Fibrillation for Men and Women

	1990	1995	2000	2005	2010
Men					
Global, all ages	54.3 (39.2–72.7)	56.5 (41.3–75.5)	59.1 (43.5–79.2)	61.7 (45.0–81.4)	64.5 (46.8–84.2)
Age ≥35 y	125.2 (90.5–167.1)	130.4 (95.8–174.0)	136.6 (100.9–182.7)	142.6 (104.1–188.0)	149.3 (108.7–194.5)
Developed countries	63.4 (47.2–83.9)	67.8 (50.7–89.5)	72.8 (54.7–94.9)	77.2 (58.4–100.5)	81.5 (60.8–106.2)
Developing countries	48.2 (33.3–65.6)	49.2 (34.5–67.8)	50.6 (35.6–69.4)	52.2 (36.4–70.9)	54.5 (37.7–73.2)
Women					
Global, all ages	38.6 (28.9–50.5)	40.3 (29.9–52.5)	43.1 (32.6–55.3)	45.0 (35.3–57.0)	45.9 (35.7–58.5)
Age ≥35 y	89.3 (67.1–116.6)	93.5 (69.5–121.2)	100.2 (76.1–128.2)	104.6 (82.3–132.1)	106.8 (82.9–135.8)
Developed countries	39.6 (30.0–51.8)	42.6 (32.5–54.7)	47.0 (36.9–59.9)	50.1 (40.0–63.2)	51.0 (39.8–63.7)
Developing countries	37.0 (26.3–49.5)	37.6 (26.6–51.3)	38.9 (27.8–53.2)	39.8 (29.2–52.5)	41.1 (30.5–54.4)

DALY indicates disability-adjusted life-years.

with making accurate estimates of the burden of this disease. Therefore, our findings could represent an underestimate. In addition, we note that differences in the extent of patient surveillance, including access to health care, use of routine ECGs, and assessment of electrical devices such as pacemakers, may be contributing to secular trends. We also acknowledge the inability of observational data to accurately estimate the relative importance of various factors contributing to such trends. Moreover, we cannot rule out the possible impact of publication bias and did not actively seek out unpublished manuscripts or data. Estimation of the mortality associated with AF was based on modeling the causes of death using input from all available cause of death data. As with any cause-of-death analysis, assignment of cause of death may be prone to some misclassification. Furthermore, any inferences about future trends should be made with caution because the rapid development of surveillance and treatment strategies might change mortality and prevalence rates. Because of the low availability of data from several regions, our findings should be interpreted with caution. Regional differences in AF burden exist, but our observations may not always be a reliable estimate as a result of the geographical disparity of data density and nonrepresentative population bias, as well as estimates based on imputations. However, even though the need for better estimates, particularly in the developing world, is crucial, our report likely represents the best available data source for global policy and decision making. Targeted population surveillance studies of AF could fill the gaps in data and permit more reliable estimates of burden of disease in coming decades.

Conclusions

There have been progressive increases in the worldwide prevalence and incidence of AF with significant effects on associated morbidity and mortality, findings that have implications for public health policy and healthcare costs. Evidence for geographic variation in AF burden, especially in developing versus developed nations, indicates that systematic, global surveillance of AF is required to formulate effective region-specific prevention and treatment strategies.

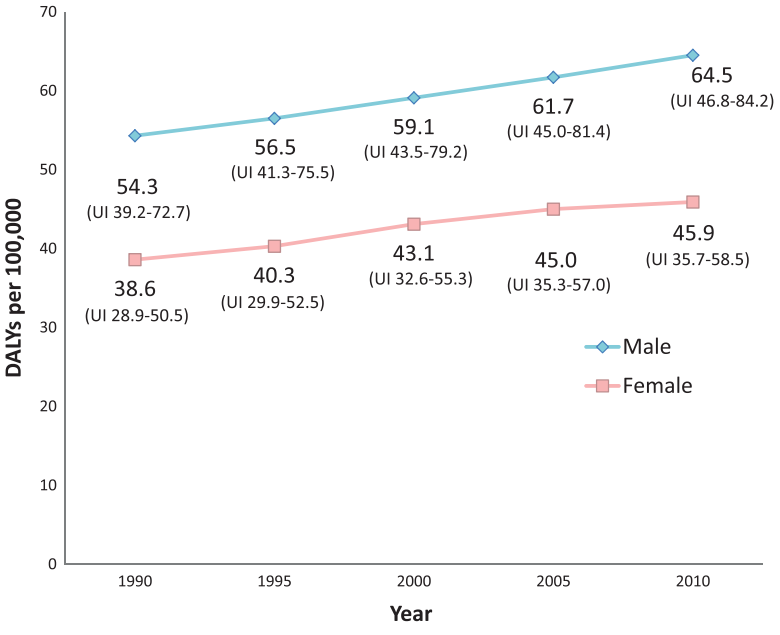

Figure 8. Disability-adjusted life-years (DALYs) related to atrial fibrillation. Estimated age-adjusted DALYs (per 100 000) related to atrial fibrillation: 1990 to 2010. UI indicates uncertainty index.

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Disclosures

None.

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CLINICAL PERSPECTIVE

Atrial fibrillation (AF) is the most common heart rhythm disorder around the world. We report results of the first global assessment of AF, conducted within the framework of the recently published Global Burden of Diseases, Injuries, and Risk Factors Study (the GBD 2010 Study). The estimated global prevalence of AF in 2010 was 33.5 million (20.9 million men and 12.6 million women). Between 1990 and 2010, there were significant increases in the estimated age-adjusted prevalence and incidence of AF. These increases were accompanied by increases in AF disease burden measured as disability-adjusted life-years and mortality associated with AF. Our findings indicate progressive increases in the worldwide prevalence and incidence of AF, as well as associated morbidity and mortality. Systematic, global surveillance of AF is required to better direct prevention and treatment strategies. As the first assessment of the global burden of AF, these findings have important implications for public health policy and healthcare costs.