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Atrial fibrillation in immigrant groups: a cohort study of all adults 45 years of age and older in Sweden

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Abstract To study the association between country of birth and incident atrial fibrillation (AF) in several immigrant groups in Sweden. The study population included all adults ($n = 3,226,752$) aged 45 years and older in Sweden. AF was defined as having at least one registered diagnosis of AF in the National Patient Register. The incidence of AF in different immigrant groups, using Swedish-born as referents, was assessed by Cox regression, expressed in hazard ratios (HRs) and 95% confidence intervals (CI). All models were

stratified by sex and adjusted for age, geographical residence in Sweden, educational level, marital status, and neighbourhood socioeconomic status. Compared to their Swedish-born counterparts, higher incidence of AF [HR (95% CI)] was observed among men from Bosnia 1.74 (1.56–1.94) and Latvia 1.29 (1.09–1.54), and among women from Iraq 1.96 (1.67–2.31), Bosnia 1.88 (1.61–1.94), Finland 1.14 (1.11–1.17), Estonia 1.14 (1.05–1.24) and Germany 1.08 (1.03–1.14). Lower incidence of AF was noted among men (HRs ≤ 0.60) from Iceland, Southern Europe (especially Greece, Italy and Spain), Latin America (especially Chile), Africa, Asia (including Iraq, Turkey, Lebanon and Iran), and among women from Nordic countries (except Finland), Southern Europe, Western Europe (except Germany), Africa, North America, Latin America, Iran, Lebanon and other Asian countries (except Turkey and Iraq). In conclusion, we observed substantial differences in incidence of AF between immigrant groups and the Swedish-born population. A greater awareness of the increased risk of AF development in some immigrant groups may enable for a timely diagnosis, treatment and prevention of its debilitating complications, such as stroke.

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Keywords Atrial fibrillation · Gender · First generation immigrants · Neighbourhood · Second generation immigrants · Socioeconomic status

Introduction

Atrial fibrillation (AF) is the most common form of arrhythmia. AF is associated with significant morbidity, in particular with an increased risk of stroke [1, 2]. In 2010, the age-adjusted prevalence of AF worldwide was estimated at approximately 0.6% among men and 0.4% among

women [3]. The AF prevalence in Europe was previously estimated to be around 1% [4]. One study conducted in Sweden found the prevalence of a registered diagnosis of AF to be around 2% [5]. As regards to people 20 years of age and older, recent figures show a prevalence of AF in Europe of 2% [6], and in Sweden of 3% [7].

Migration worldwide is on the increase. In Sweden, it is estimated that approximately 17% of the registered Swedish population is foreign-born (data from Statistics Sweden) [8]. The health of immigrants upon arrival to their new country often tends to be better than that of the native population; something that has been termed as the “healthy migrant effect”. This improved health status in some countries could be a result of a selective immigration process in which people are granted entry to a new country if they have passed a medical screening examination. However, such a selection is uncommon for immigrants to Sweden. Additionally, the health of immigrants tends to decline with years spent living in their new adopted country [9, 10]. The relation between immigration and health is complex due to the ethnic, cultural and economic diversity of immigrants. Ethnic differences in the incidence and prevalence of AF [11], as well as in symptoms and treatment [12], have been reported previously. In the United States, a lower AF risk has earlier been reported among Afro-Americans compared to individuals of white European descent [13] and among Chinese and Hispanics compared to non-Hispanic whites [11]. In Europe, AF rates in the UK are lower among South Asians, despite a higher cardiovascular risk profile, than in the native British population [14]. However, there are few other studies on this topic besides those mentioned above.

Therefore, the aim of this study was to explore the risk of being diagnosed with AF among first and second-generation immigrants in Sweden and whether that risk differed from the Swedish-born population, after taking potential confounders into account.

Methods

Design

The registers used in the present study were the Total Population Register and the National Patient Register. Sweden’s nationwide population and health care registers have exceptionally high completeness and validity [15]. Less than 1% of the data were missing when linking clinical to national demographic and socioeconomic data. Individuals were tracked using the personal identification numbers, which are assigned to each resident of Sweden. Migrants with a residence permit get a Swedish personal identification number. Asylum seekers are thus not

included until they receive their residence permit, but in general they form a limited number of individuals. These identification numbers were replaced with serial numbers to ensure anonymity. Subjects aged 45 years of age and older were included in the study. The follow-up period ran from January 1, 1998 until hospitalisation/out-patient treatment of AF at age of diagnosis of 45 years or more, death, emigration or the end of the study period on December 31, 2012, whichever came first. Out-patient diagnoses were included nationwide from 2001 and onwards from specialist care, not primary health care.

Study population and co-morbidities

The study included the whole Swedish population aged 45 years and older. Patients with an AF diagnosis prior to January 1, 1998 were excluded in order to “wash-out” those with pre-existing disease. Country of birth was registered and the present study was based on analyses of ten regions (Nordic countries, Southern Europe, Western Europe, Eastern Europe, Baltic countries, Central Europe, Africa, North America, Latin America and Asia) and separate analyses from 27 countries (Supplementary Table 1). Countries with less than 10 observed cases of AF were not analysed separately. First-generation immigrants ($n = 434,440$) were defined as those born outside Sweden and were compared to Swedish-born individuals. “The date of immigration” is actually the date of residence permit, i.e. when the migrants get their Swedish personal identification number. Second-generation immigrants were defined ($n = 121,414$) as individuals born in Sweden with at least one foreign-born parent and were compared to individuals born in Sweden with two Swedish-born parents.

Patients with diagnosed AF were identified by the presence of the ICD-10 code (10th version of the World Health Organization’s International Classification of Diseases) for AF (I48) in the National Patient Register. AF diagnosed before 1998, i.e. during the years 1987–1997 (according to ICD-9 1987–1996 and ICD-10 1997) were excluded. We also identified co-morbidities according to ICD-10 for the following diagnoses: hypertension I10-I19, chronic rheumatic heart disease I05-I09, CHD I20-I25, heart failure I50, stroke I60-I69, diabetes E10-E14, obesity E65-E68, alcoholism and related disorders F10 and K70, and chronic obstructive pulmonary disease (COPD) J40-J47.

Outcome variable

Time was calculated from January 1, 1998 until hospitalisation/out-patient treatment of AF (among individuals at an age of diagnosis of 45 years or older), death, emigration or the end of the study period on December 31, 2012, whichever came first.

Demographic and socioeconomic variables

The study population was stratified by *sex*.

Age was used as a continuous variable in the analysis.

Educational attainment was categorised as ≤ 9 years (partial or complete compulsory schooling), 10–12 years (partial or complete secondary schooling) and >12 years (attendance at college and/or university).

Geographic region of residence was included in order to adjust for possible regional differences in hospital admissions and was categorised as [1] large cities, [2] southern Sweden and [3] northern Sweden. Large cities were defined as municipalities with a population of $>200,000$ and comprised the three largest cities in Sweden: Stockholm, Gothenburg and Malmö.

Neighbourhood socioeconomic status

Neighbourhoods were derived from Small Area Market Statistics (SAMS). These were originally created for commercial purposes and pertain to small geographic areas with boundaries defined by homogenous types of buildings. The average population in each SAMS neighbourhood is approximately 2000 people for Stockholm and 1000 people for the rest of Sweden. A summary index was calculated to characterise neighbourhood-level deprivation. The neighbourhood index was based on information about female and male residents aged 20–64 years. The logic for this is because this age group represents those who are among the most socioeconomically active in the population (i.e. a group that has a stronger impact on the socioeconomic structure in the neighbourhood compared to children, younger women and men, and retirees). The index was based on the following four variables: low educational status (<10 years of formal education); income from all sources, including interest and dividends, that is $<50\%$ of the median individual income); unemployment (excluding full-time students, those completing military service and early retirees); and receipt of social welfare. The index was categorised into three groups: more than one standard deviation (SD) below the mean (high SES or low-deprivation level), more than one SD above the mean (low SES or high-deprivation level), and within one SD of the mean (middle SES or middle-deprivation level) [16], with neighbourhood status classified as high, middle or low SES, corresponding to the categories low, middle and high-deprivation in the index [17].

Statistical analysis

The number of AF cases was presented for first- and second-generation immigrants and across baseline subject characteristics. Cox regression analysis was used for estimating the risk of incident AF in different immigrant

groups compared to the Swedish-born population. All analyses were stratified by *sex*. Three models were used in our analyses: Model 1 was adjusted for age and region of residence in Sweden; Model 2 was adjusted for age, region of residence in Sweden, educational level, marital status and neighbourhood SES; Model 3 was constructed as Model 2 with inclusion of co-morbidities. In addition, Cox regression sensitivity analyses were performed in which first-generation immigrants moving to Sweden within the last 5 years of follow-up were excluded.

The study was approved by the regional ethics boards at Karolinska Institutet and Lund University.

Results

Table 1 features the characteristics of the included samples for analysis for first- and second-generation immigrants 45 years of age and above. There were 9.4% of people diagnosed with AF among first-generation immigrants; 5.7% for second-generation immigrants. AF was less common among immigrants in general compared to Swedish-born individuals. AF was also less common among females, individuals with a higher level of formal education, married individuals, and people living in northern Sweden, while AF was more common among individuals with co-morbidities, especially cardiovascular co-morbidities.

Table 2a, b show the incidence of AF in first generation male and female immigrants, respectively, compared to their Swedish-born counterparts. In comparison to Swedish-born men, the incidence of AF was higher among male immigrants with Bosnian origin, after adjustment for age, region of residence in Sweden, educational level, marital status, neighbourhood SES and co-morbidity. By contrast, compared to Swedish-born men, the incidence of AF was lower in men originating from most other regions and countries, but especially low ($HRs \leq 0.60$) among immigrant men from Iceland, from Southern Europe (especially Greece, Italy and Spain), Latin America (especially Chile), Africa, Asia and specifically Iraq, Turkey, Lebanon and Iran. Compared to Swedish-born women, the incidence of AF was higher among immigrant women from Bosnia and Iraq and there was a borderline significant increase among women from Finland and Estonia. A lower incidence of AF was observed among immigrant women from most other regions and countries and was especially low for women ($HRs \leq 0.60$) from Iceland, Greece, Italy, Africa, and Latin America.

Table 3a, b show the incidence of AF in the second-generation male and female immigrants, respectively, compared to their Swedish-born counterparts. An increased incidence of AF was found only in the fully adjusted model among males from the Netherlands and not among any female immigrant groups, after adjusting for age, region of

Table 1 Population and number of incident cases of atrial fibrillation (AF) diagnoses in the Swedish population, used to study AF in first-generation and second-generation immigrants compared to Swedish-born individuals

| | First-generation analysis | | | | Second-generation analysis | | | |
|--|---------------------------|------|--------------|------|----------------------------|------|--------------|------|
| | Population | | AF diagnosis | | Population | | AF diagnosis | |
| | No | % | No. | % | No | % | No. | % |
| Total population | 3,226,752 | | 304,487 | | 1,890,853 | | 107,213 | |
| Gender | | | | | | | | |
| Males | 1,520,562 | 47.1 | 159,769 | 52.5 | 950,316 | 50.3 | 70,631 | 65.9 |
| Females | 1,706,190 | 52.9 | 144,718 | 47.5 | 940,537 | 49.7 | 36,582 | 34.1 |
| Country of origin ^a | | | | | | | | |
| Sweden | 2,792,312 | 86.5 | 278,472 | 91.5 | 1,769,439 | 93.6 | 101,985 | 95.1 |
| Other countries | 434,440 | 13.5 | 26,015 | 8.5 | 121,414 | 6.4 | 5228 | 4.9 |
| Birth year | | | | | | | | |
| –1909 | 73,467 | 2.3 | 4945 | 1.6 | | | | |
| 1910–1919 | 323,206 | 10.0 | 51,267 | 16.8 | | | | |
| 1920–1929 | 602,445 | 18.7 | 106,131 | 34.9 | | | | |
| 1930–39 | 722,107 | 22.4 | 79,921 | 26.2 | 441,357 | 23.3 | 45,472 | 42.4 |
| 1940–1949 | 1,088,739 | 33.7 | 52,610 | 17.3 | 1,034,701 | 54.7 | 51,589 | 48.1 |
| 1950– | 416,788 | 12.9 | 9613 | 3.2 | 414,795 | 21.9 | 10,152 | 9.5 |
| Educational level | | | | | | | | |
| ≤9 | 1,511,090 | 46.8 | 162,796 | 53.5 | 606,689 | 32.1 | 38,917 | 36.3 |
| 10–12 | 811,538 | 25.2 | 68,676 | 22.6 | 569,256 | 30.1 | 29,557 | 27.6 |
| >12 | 904,124 | 28.0 | 73,015 | 24.0 | 714,908 | 37.8 | 38,739 | 36.1 |
| Region of residence | | | | | | | | |
| Large cities | 1,075,763 | 33.3 | 110,525 | 36.3 | 642,798 | 34.0 | 38,166 | 35.6 |
| Southern Sweden | 1,424,349 | 44.1 | 140,915 | 46.3 | 868,490 | 45.9 | 49,178 | 45.9 |
| Northern Sweden | 726,640 | 22.5 | 53,047 | 17.4 | 379,565 | 20.1 | 19,869 | 18.5 |
| Marital status | | | | | | | | |
| Married | 2,612,169 | 81.0 | 235,927 | 77.5 | 1,515,664 | 80.2 | 82,165 | 76.6 |
| Unmarried | 614,583 | 19.0 | 68,560 | 22.5 | 375,189 | 19.8 | 25,048 | 23.4 |
| Neighbourhood deprivation | | | | | | | | |
| Low | 485,193 | 15.0 | 43,082 | 14.1 | 337,143 | 17.8 | 18,330 | 17.1 |
| Middle | 1,622,097 | 50.3 | 164,111 | 53.9 | 971,071 | 51.4 | 56,101 | 52.3 |
| High | 359,648 | 11.1 | 36,422 | 12.0 | 194,895 | 10.3 | 11,617 | 10.8 |
| Unknown | 759,814 | 23.5 | 60,872 | 20.0 | 387,744 | 20.5 | 21,165 | 19.7 |
| Hospital diagnosis of COPD | | | | | | | | |
| No | 3,024,792 | 93.7 | 271,514 | 89.2 | 1,793,433 | 94.8 | 96,629 | 90.1 |
| Yes | 201,960 | 6.3 | 32,973 | 10.8 | 97,420 | 5.2 | 10,584 | 9.9 |
| Hospital diagnosis of obesity | | | | | | | | |
| No | 3,199,756 | 99.2 | 300,514 | 98.7 | 1,868,020 | 98.8 | 104,092 | 97.1 |
| Yes | 26,996 | 0.8 | 3973 | 1.3 | 22,833 | 1.2 | 3121 | 2.9 |
| Hospital diagnosis of CHD | | | | | | | | |
| No | 2,747,889 | 85.2 | 203,705 | 66.9 | 1,705,792 | 90.2 | 79,507 | 74.2 |
| Yes | 478,863 | 14.8 | 100,782 | 33.1 | 185,061 | 9.8 | 27,706 | 25.8 |
| Hospital diagnosis of diabetes | | | | | | | | |
| No | 2,942,192 | 91.2 | 259,615 | 85.3 | 1,746,278 | 92.4 | 90,514 | 84.4 |
| Yes | 284,560 | 8.8 | 44,872 | 14.7 | 144,575 | 7.6 | 16,699 | 15.6 |
| Hospital diagnosis of alcoholism and related disorders | | | | | | | | |
| No | 3,160,834 | 98.0 | 297,828 | 97.8 | 1,832,992 | 96.9 | 102,324 | 95.4 |
| Yes | 65,918 | 2.0 | 6659 | 2.2 | 57,861 | 3.1 | 4889 | 4.6 |
| Hospital diagnosis of stroke | | | | | | | | |
| No | 2,895,083 | 89.7 | 227,755 | 74.8 | 1,784,381 | 94.4 | 90,851 | 84.7 |

Table 1 continued

| | First-generation analysis | | | | Second-generation analysis | | | |
|---|---------------------------|------|--------------|------|----------------------------|------|--------------|------|
| | Population | | AF diagnosis | | Population | | AF diagnosis | |
| | No | % | No. | % | No | % | No. | % |
| Yes | 331,669 | 10.3 | 76,732 | 25.2 | 106,472 | 5.6 | 16,362 | 15.3 |
| Hospital diagnosis of hypertension | | | | | | | | |
| No | 2,573,075 | 79.7 | 180,959 | 59.4 | 1,542,546 | 81.6 | 56,754 | 52.9 |
| Yes | 653,677 | 20.3 | 123,528 | 40.6 | 348,307 | 18.4 | 50,459 | 47.1 |
| Hospital diagnosis of heart failure | | | | | | | | |
| No | 2,939,005 | 91.1 | 194,225 | 63.8 | 1,826,817 | 96.6 | 82,429 | 76.9 |
| Yes | 287,747 | 8.9 | 110,262 | 36.2 | 64,036 | 3.4 | 24,784 | 23.1 |
| Hospital diagnosis of chronic rheumatic heart disease | | | | | | | | |
| No | 3,220,896 | 99.8 | 301,799 | 99.1 | 1,888,802 | 99.9 | 106,320 | 99.2 |
| Yes | 5856 | 0.2 | 2688 | 0.9 | 2051 | 0.1 | 893 | 0.8 |

^a Immigrant status in second generation was based on parental birth country

residence, educational level, marital status, neighbourhood SES and co-morbidity. Second-generation male immigrants from Italy and Latin America had a lower incidence (with HRs ≤ 0.60) of AF compared to their Swedish-born counterparts. Among second-generation immigrant women, compared to Swedish-born women, a lower incidence of AF (with HRs ≤ 0.60) was observed for those women with origin from Southern Europe, especially from Italy.

The results of the sensitivity analyses performed in first-generation immigrants (Supplementary Table 2) confirmed the results from Table 2a, b, and only small differences were observed.

Discussion

This study explored the risk of being diagnosed with incident AF among first and second-generation immigrant men and women in Sweden compared to Swedish-born men and women aged 45 years and older. Both higher and lower estimates of AF were detected in the different immigrant groups. Higher estimates were found among first-generation immigrants for both men and women from Bosnia and among women from Iraq, while no excess incidence of AF was found among second-generation immigrants. Furthermore, compared to Swedes, lower incidence of AF was found in first-generation immigrants for most other immigrant groups, while this was true only for a few groups of the second-generation immigrant groups, i.e. among men from Germany and Hungary, and women from Italy and Central Europe.

AF prevalence differs around the world and some differences are to be expected, in particular a lower AF

incidence among immigrants of non-European descent from non-Western countries [18]. This could explain the lower incidence among immigrants from certain regions, such as Africa, Latin America and many Asian countries. Furthermore, individuals living in Northern Europe traditionally have a higher risk of coronary heart disease (CHD), especially compared to Southern Europe. As myocardial infarction is a risk factor for AF [19], the lower AF incidence among most immigrant groups could reflect a higher AF incidence and prevalence in Sweden [6].

There were some findings that could not be easily interpreted. For instance, the AF incidence differed among immigrants from different regions of Europe, with lower incidence among immigrants from most European regions. However, there were some important exceptions, in particular the increased incidence among men and women from Bosnia. Risk factors for AF include older age, sex, genetics, hypertension, heart disease (heart failure and coronary artery disease), being overweight and obese, higher amount of pericardial fat, sleep apnea, atrial dilatation and stretch, chronic kidney disease, smoking, high alcohol consumption, diabetes and thyroid dysfunction [20]. The risk pattern differs in different immigrant groups and could contribute to, and possibly explain, differences in AF incidence. We were able to adjust for some co-morbidities, especially cardiovascular co-morbidity, but not for other clinical factors. Some ethnic differences in the risk factor pattern for AF have been shown, i.e. hypertension [21], diabetes [22], smoking [23] and obesity [22]. Even if hypertension is the most commonly established risk factor for AF worldwide, other factors such as rheumatic and valvular heart diseases seem to be more important for AF in populations living in Latin America, India, the

Table 2 Incidence of [hazard ratio (HR) with 95% confidence intervals (95% CI)] AF in (a) first-generation male immigrants compared to Swedish-born (N = 1,520,562), (b) first-generation female immigrants compared to Swedish-born individuals (N = 1,706,190)

| | Model 1 | | | Model 2 | | | Model 3 | | |
|-----------------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| | HR | 95% CI | | HR | 95% CI | | HR | 95% CI | |
| <i>(a)</i> | | | | | | | | | |
| Sweden | 1 | | | 1 | | | 1 | | |
| Nordic countries | 0.76 | 0.74 | 0.78 | 0.85 | 0.83 | 0.87 | 0.83 | 0.81 | 0.86 |
| Denmark | 0.68 | 0.64 | 0.72 | 0.70 | 0.66 | 0.74 | 0.71 | 0.67 | 0.75 |
| Finland | 0.78 | 0.76 | 0.81 | 0.91 | 0.88 | 0.94 | 0.87 | 0.85 | 0.90 |
| Iceland | 0.24 | 0.16 | 0.36 | 0.29 | 0.20 | 0.44 | 0.34 | 0.22 | 0.50 |
| Norway | 0.80 | 0.75 | 0.85 | 0.86 | 0.81 | 0.91 | 0.87 | 0.82 | 0.93 |
| Southern Europe | 0.37 | 0.34 | 0.40 | 0.44 | 0.40 | 0.48 | 0.48 | 0.44 | 0.52 |
| France | 0.53 | 0.41 | 0.67 | 0.62 | 0.49 | 0.79 | 0.66 | 0.52 | 0.84 |
| Greece | 0.28 | 0.24 | 0.33 | 0.35 | 0.30 | 0.41 | 0.40 | 0.34 | 0.46 |
| Italy | 0.44 | 0.38 | 0.51 | 0.52 | 0.45 | 0.60 | 0.53 | 0.46 | 0.61 |
| Spain | 0.36 | 0.28 | 0.45 | 0.44 | 0.34 | 0.55 | 0.48 | 0.38 | 0.61 |
| Other Southern Europe | 0.34 | 0.25 | 0.48 | 0.36 | 0.26 | 0.50 | 0.41 | 0.29 | 0.57 |
| Western Europe | 0.70 | 0.67 | 0.74 | 0.76 | 0.73 | 0.80 | 0.77 | 0.74 | 0.81 |
| The Netherlands | 0.63 | 0.52 | 0.77 | 0.69 | 0.57 | 0.83 | 0.72 | 0.59 | 0.87 |
| UK and Ireland | 0.46 | 0.39 | 0.53 | 0.54 | 0.47 | 0.63 | 0.61 | 0.52 | 0.71 |
| Germany | 0.77 | 0.72 | 0.82 | 0.81 | 0.76 | 0.86 | 0.80 | 0.76 | 0.85 |
| Austria | 0.77 | 0.68 | 0.88 | 0.84 | 0.74 | 0.95 | 0.83 | 0.73 | 0.94 |
| Other Western Europe | 0.59 | 0.47 | 0.75 | 0.69 | 0.54 | 0.87 | 0.72 | 0.57 | 0.91 |
| Eastern Europe | 0.75 | 0.71 | 0.79 | 0.78 | 0.74 | 0.83 | 0.78 | 0.74 | 0.83 |
| Bosnia | 1.28 | 1.12 | 1.46 | 1.80 | 1.58 | 2.06 | 1.48 | 1.30 | 1.69 |
| Yugoslavia | 0.68 | 0.64 | 0.73 | 0.70 | 0.65 | 0.75 | 0.71 | 0.66 | 0.76 |
| Croatia | 0.73 | 0.58 | 0.92 | 0.68 | 0.55 | 0.86 | 0.73 | 0.58 | 0.92 |
| Romania | 0.75 | 0.62 | 0.90 | 0.76 | 0.63 | 0.92 | 0.75 | 0.62 | 0.90 |
| Bulgaria | 0.60 | 0.42 | 0.86 | 0.65 | 0.45 | 0.93 | 0.70 | 0.49 | 1.00 |
| Other Eastern Europe | 0.71 | 0.50 | 1.01 | 0.64 | 0.45 | 0.91 | 0.67 | 0.47 | 0.96 |
| Baltic countries | 1.05 | 0.97 | 1.14 | 1.10 | 1.02 | 1.20 | 1.07 | 0.99 | 1.16 |
| Estonia | 1.03 | 0.94 | 1.12 | 1.08 | 0.99 | 1.18 | 1.05 | 0.96 | 1.15 |
| Latvia | 1.17 | 0.96 | 1.42 | 1.21 | 0.99 | 1.47 | 1.19 | 0.98 | 1.44 |
| Central Europe | 0.79 | 0.74 | 0.84 | 0.79 | 0.75 | 0.84 | 0.75 | 0.71 | 0.80 |
| Poland | 0.76 | 0.69 | 0.84 | 0.77 | 0.70 | 0.85 | 0.73 | 0.67 | 0.81 |
| Other Central Europe | 0.80 | 0.70 | 0.92 | 0.81 | 0.71 | 0.93 | 0.78 | 0.68 | 0.89 |
| Hungary | 0.81 | 0.73 | 0.89 | 0.80 | 0.73 | 0.88 | 0.76 | 0.69 | 0.84 |
| Africa | 0.41 | 0.36 | 0.48 | 0.48 | 0.42 | 0.56 | 0.51 | 0.43 | 0.59 |
| North America | 0.61 | 0.54 | 0.69 | 0.69 | 0.61 | 0.78 | 0.72 | 0.64 | 0.82 |
| Latin America | 0.29 | 0.25 | 0.34 | 0.34 | 0.29 | 0.39 | 0.38 | 0.32 | 0.45 |
| Chile | 0.26 | 0.21 | 0.32 | 0.30 | 0.24 | 0.37 | 0.33 | 0.27 | 0.42 |
| South America | 0.34 | 0.27 | 0.43 | 0.39 | 0.31 | 0.49 | 0.45 | 0.36 | 0.57 |
| Asia | 0.48 | 0.45 | 0.51 | 0.55 | 0.52 | 0.59 | 0.53 | 0.49 | 0.56 |
| Turkey | 0.47 | 0.41 | 0.54 | 0.56 | 0.49 | 0.65 | 0.53 | 0.46 | 0.61 |
| Lebanon | 0.41 | 0.30 | 0.55 | 0.48 | 0.36 | 0.65 | 0.43 | 0.32 | 0.58 |
| Iran | 0.39 | 0.33 | 0.45 | 0.41 | 0.35 | 0.48 | 0.41 | 0.35 | 0.48 |
| Iraq | 0.80 | 0.68 | 0.92 | 1.00 | 0.86 | 1.16 | 0.83 | 0.71 | 0.96 |
| Other Asia countries | 0.45 | 0.40 | 0.51 | 0.52 | 0.47 | 0.59 | 0.51 | 0.46 | 0.58 |
| Russia | 1.07 | 0.93 | 1.23 | 1.11 | 0.97 | 1.28 | 1.01 | 0.88 | 1.16 |
| <i>(b)</i> | | | | | | | | | |
| Sweden | 1 | | | 1 | | | 1 | | |
| Nordic countries | 0.96 | 0.94 | 0.98 | 1.01 | 0.99 | 1.04 | 0.97 | 0.95 | 0.99 |

Table 2 continued

| | Model 1 | | | Model 2 | | | Model 3 | | |
|-----------------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| | HR | 95% CI | | HR | 95% CI | | HR | 95% CI | |
| Denmark | 0.78 | 0.73 | 0.83 | 0.79 | 0.74 | 0.84 | 0.81 | 0.75 | 0.86 |
| Finland | 1.02 | 0.99 | 1.05 | 1.10 | 1.07 | 1.13 | 1.03 | 1.00 | 1.06 |
| Iceland | 0.37 | 0.24 | 0.57 | 0.43 | 0.28 | 0.66 | 0.50 | 0.32 | 0.78 |
| Norway | 0.91 | 0.86 | 0.96 | 0.92 | 0.87 | 0.97 | 0.89 | 0.85 | 0.94 |
| Southern Europe | 0.42 | 0.37 | 0.48 | 0.48 | 0.43 | 0.54 | 0.55 | 0.49 | 0.62 |
| France | 0.62 | 0.46 | 0.82 | 0.72 | 0.54 | 0.96 | 0.79 | 0.59 | 1.06 |
| Greece | 0.30 | 0.24 | 0.38 | 0.35 | 0.28 | 0.44 | 0.42 | 0.33 | 0.53 |
| Italy | 0.38 | 0.30 | 0.48 | 0.44 | 0.35 | 0.56 | 0.49 | 0.39 | 0.62 |
| Spain | 0.61 | 0.46 | 0.82 | 0.70 | 0.52 | 0.94 | 0.77 | 0.58 | 1.03 |
| Other Southern Europe | 0.57 | 0.38 | 0.87 | 0.59 | 0.39 | 0.90 | 0.66 | 0.44 | 1.00 |
| Western Europe | 0.90 | 0.86 | 0.95 | 0.97 | 0.92 | 1.02 | 0.96 | 0.91 | 1.01 |
| The Netherlands | 0.72 | 0.56 | 0.93 | 0.80 | 0.62 | 1.03 | 0.85 | 0.66 | 1.10 |
| UK and Ireland | 0.48 | 0.39 | 0.59 | 0.55 | 0.45 | 0.68 | 0.61 | 0.50 | 0.76 |
| Germany | 0.98 | 0.93 | 1.04 | 1.04 | 0.98 | 1.10 | 1.01 | 0.95 | 1.06 |
| Austria | 0.96 | 0.82 | 1.12 | 1.03 | 0.88 | 1.20 | 1.01 | 0.87 | 1.18 |
| Other Western Europe | 0.62 | 0.46 | 0.85 | 0.72 | 0.53 | 0.98 | 0.75 | 0.55 | 1.03 |
| Eastern Europe | 0.96 | 0.89 | 1.03 | 0.98 | 0.91 | 1.05 | 0.97 | 0.90 | 1.04 |
| Bosnia | 1.54 | 1.27 | 1.87 | 2.03 | 1.67 | 2.46 | 1.67 | 1.38 | 2.03 |
| Yugoslavia | 0.90 | 0.82 | 0.98 | 0.89 | 0.82 | 0.98 | 0.90 | 0.82 | 0.99 |
| Croatia | 1.05 | 0.78 | 1.41 | 0.99 | 0.74 | 1.34 | 1.06 | 0.79 | 1.43 |
| Romania | 0.81 | 0.63 | 1.04 | 0.86 | 0.67 | 1.11 | 0.80 | 0.62 | 1.03 |
| Bulgaria | 0.83 | 0.51 | 1.33 | 0.95 | 0.59 | 1.52 | 0.95 | 0.59 | 1.53 |
| Other Eastern Europe | 1.09 | 0.63 | 1.87 | 0.98 | 0.57 | 1.69 | 0.98 | 0.57 | 1.69 |
| Baltic countries | 1.05 | 0.97 | 1.14 | 1.13 | 1.05 | 1.23 | 1.08 | 0.99 | 1.17 |
| Estonia | 1.07 | 0.98 | 1.16 | 1.15 | 1.05 | 1.25 | 1.10 | 1.00 | 1.20 |
| Latvia | 0.96 | 0.77 | 1.20 | 1.05 | 0.84 | 1.30 | 0.97 | 0.78 | 1.21 |
| Central Europe | 0.90 | 0.84 | 0.97 | 0.93 | 0.87 | 1.00 | 0.87 | 0.81 | 0.94 |
| Poland | 0.91 | 0.83 | 1.01 | 0.94 | 0.85 | 1.04 | 0.86 | 0.78 | 0.95 |
| Other Central Europe | 0.77 | 0.65 | 0.91 | 0.81 | 0.69 | 0.96 | 0.81 | 0.68 | 0.95 |
| Hungary | 0.98 | 0.87 | 1.11 | 1.01 | 0.90 | 1.15 | 0.93 | 0.82 | 1.05 |
| Africa | 0.47 | 0.33 | 0.68 | 0.54 | 0.38 | 0.78 | 0.55 | 0.38 | 0.80 |
| North America | 0.80 | 0.71 | 0.90 | 0.87 | 0.77 | 0.98 | 0.89 | 0.79 | 1.01 |
| Latin America | 0.41 | 0.33 | 0.50 | 0.45 | 0.37 | 0.55 | 0.48 | 0.39 | 0.59 |
| Chile | 0.42 | 0.32 | 0.55 | 0.46 | 0.35 | 0.61 | 0.48 | 0.37 | 0.64 |
| South America | 0.39 | 0.29 | 0.54 | 0.44 | 0.32 | 0.60 | 0.48 | 0.35 | 0.65 |
| Asia | 0.81 | 0.75 | 0.89 | 0.89 | 0.81 | 0.97 | 0.83 | 0.76 | 0.91 |
| Turkey | 0.92 | 0.79 | 1.08 | 1.00 | 0.86 | 1.17 | 0.89 | 0.77 | 1.04 |
| Lebanon | 0.69 | 0.45 | 1.06 | 0.75 | 0.49 | 1.14 | 0.61 | 0.40 | 0.94 |
| Iran | 0.72 | 0.57 | 0.91 | 0.76 | 0.60 | 0.96 | 0.76 | 0.60 | 0.95 |
| Iraq | 1.55 | 1.23 | 1.96 | 1.91 | 1.51 | 2.41 | 1.52 | 1.20 | 1.92 |
| Other Asian countries | 0.65 | 0.56 | 0.76 | 0.71 | 0.61 | 0.83 | 0.71 | 0.61 | 0.83 |
| Russia | 0.98 | 0.85 | 1.14 | 1.03 | 0.89 | 1.19 | 0.92 | 0.80 | 1.07 |

Model 1 was adjusted for age and region of residence in Sweden; Model 2 was adjusted for age, region of residence in Sweden, educational level, marital status and neighbourhood SES; Model 3 was constructed as Model 2 with inclusion of co-morbidities

Significant values HRs and 95% CIs marked by bold

Table 3 Incidence of [hazard ratio (HR) with 95% confidence intervals (95% CI)] AF in (a) second-generation male immigrants compared to Swedish-born individuals (N = 950,316), (b) second-generation female immigrants compared to Swedish-born individuals (N = 940,537)

| | Model 1 | | | Model 2 | | | Model 3 | | |
|-----------------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| | HR | 95% CI | | HR | 95% CI | | HR | 95% CI | |
| <i>(a)</i> | | | | | | | | | |
| Sweden | 1 | | | 1 | | | 1 | | |
| Nordic countries | 0.97 | 0.93 | 1.02 | 0.98 | 0.94 | 1.02 | 0.96 | 0.91 | 1.00 |
| Denmark | 0.95 | 0.86 | 1.05 | 0.95 | 0.86 | 1.05 | 0.97 | 0.88 | 1.07 |
| Finland | 0.99 | 0.93 | 1.06 | 1.00 | 0.94 | 1.06 | 0.96 | 0.90 | 1.02 |
| Norway | 0.96 | 0.89 | 1.04 | 0.96 | 0.89 | 1.04 | 0.94 | 0.87 | 1.02 |
| Southern Europe | 0.78 | 0.60 | 1.02 | 0.80 | 0.61 | 1.04 | 0.82 | 0.63 | 1.07 |
| Italy | 0.73 | 0.50 | 1.06 | 0.74 | 0.51 | 1.08 | 0.76 | 0.52 | 1.11 |
| Western Europe | 0.90 | 0.82 | 0.99 | 0.90 | 0.82 | 0.99 | 0.90 | 0.82 | 0.99 |
| The Netherlands | 1.37 | 0.95 | 1.99 | 1.38 | 0.95 | 2.00 | 1.47 | 1.01 | 2.13 |
| UK and Ireland | 1.11 | 0.83 | 1.48 | 1.12 | 0.84 | 1.49 | 1.12 | 0.84 | 1.50 |
| Germany | 0.86 | 0.76 | 0.96 | 0.86 | 0.77 | 0.96 | 0.85 | 0.76 | 0.95 |
| Austria | 0.86 | 0.65 | 1.14 | 0.86 | 0.65 | 1.15 | 0.84 | 0.63 | 1.12 |
| Other Western Europe | 0.78 | 0.45 | 1.38 | 0.79 | 0.45 | 1.39 | 0.92 | 0.52 | 1.62 |
| Eastern Europe | 0.88 | 0.63 | 1.22 | 0.88 | 0.64 | 1.22 | 0.84 | 0.61 | 1.17 |
| Yugoslavia | 0.85 | 0.56 | 1.29 | 0.85 | 0.56 | 1.30 | 0.80 | 0.52 | 1.21 |
| Romania | 0.85 | 0.46 | 1.58 | 0.86 | 0.46 | 1.60 | 0.90 | 0.48 | 1.67 |
| Baltic countries | 0.97 | 0.87 | 1.09 | 0.98 | 0.87 | 1.10 | 0.99 | 0.89 | 1.11 |
| Estonia | 0.95 | 0.84 | 1.07 | 0.95 | 0.84 | 1.08 | 0.98 | 0.86 | 1.11 |
| Latvia | 1.14 | 0.87 | 1.51 | 1.15 | 0.87 | 1.52 | 1.10 | 0.84 | 1.45 |
| Central Europe | 0.79 | 0.66 | 0.94 | 0.79 | 0.66 | 0.94 | 0.75 | 0.63 | 0.89 |
| Poland | 0.86 | 0.68 | 1.09 | 0.86 | 0.68 | 1.09 | 0.83 | 0.65 | 1.04 |
| Other Central Europe | 1.03 | 0.75 | 1.40 | 1.03 | 0.75 | 1.40 | 0.98 | 0.72 | 1.33 |
| Hungary | 0.40 | 0.25 | 0.66 | 0.40 | 0.25 | 0.66 | 0.38 | 0.23 | 0.61 |
| Africa | 0.42 | 0.13 | 1.29 | 0.42 | 0.14 | 1.30 | 0.47 | 0.15 | 1.44 |
| North America | 0.93 | 0.83 | 1.05 | 0.94 | 0.83 | 1.06 | 0.96 | 0.85 | 1.09 |
| Latin America | 0.59 | 0.27 | 1.31 | 0.60 | 0.27 | 1.33 | 0.60 | 0.27 | 1.34 |
| Asia | 0.65 | 0.42 | 1.02 | 0.66 | 0.42 | 1.04 | 0.68 | 0.43 | 1.06 |
| Other Asian countries | 0.84 | 0.52 | 1.35 | 0.85 | 0.53 | 1.37 | 0.92 | 0.58 | 1.49 |
| Russia | 1.12 | 0.94 | 1.34 | 1.12 | 0.94 | 1.35 | 1.11 | 0.93 | 1.34 |
| <i>(b)</i> | | | | | | | | | |
| Sweden | 1 | | | 1 | | | 1 | | |
| Nordic countries | 1.04 | 0.98 | 1.10 | 1.04 | 0.98 | 1.11 | 0.99 | 0.93 | 1.05 |
| Denmark | 0.98 | 0.85 | 1.13 | 0.97 | 0.84 | 1.13 | 0.99 | 0.86 | 1.15 |
| Finland | 1.12 | 1.02 | 1.22 | 1.12 | 1.03 | 1.22 | 1.03 | 0.94 | 1.12 |
| Norway | 0.96 | 0.86 | 1.07 | 0.96 | 0.86 | 1.07 | 0.93 | 0.84 | 1.04 |
| Southern Europe | 0.51 | 0.31 | 0.84 | 0.53 | 0.33 | 0.87 | 0.58 | 0.36 | 0.95 |
| Italy | 0.24 | 0.09 | 0.64 | 0.25 | 0.09 | 0.67 | 0.28 | 0.11 | 0.75 |
| Western Europe | 0.84 | 0.73 | 0.97 | 0.86 | 0.75 | 0.99 | 0.91 | 0.79 | 1.05 |
| The Netherlands | 0.87 | 0.43 | 1.74 | 0.89 | 0.44 | 1.77 | 1.01 | 0.51 | 2.02 |
| UK and Ireland | 0.88 | 0.54 | 1.41 | 0.90 | 0.56 | 1.45 | 0.97 | 0.60 | 1.56 |
| Germany | 0.82 | 0.70 | 0.97 | 0.84 | 0.71 | 0.99 | 0.88 | 0.74 | 1.04 |
| Austria | 0.90 | 0.61 | 1.34 | 0.92 | 0.62 | 1.37 | 0.99 | 0.67 | 1.46 |
| Other Western Europe | 0.96 | 0.46 | 2.02 | 1.01 | 0.48 | 2.12 | 1.14 | 0.55 | 2.40 |
| Eastern Europe | 0.56 | 0.29 | 1.07 | 0.56 | 0.29 | 1.07 | 0.54 | 0.28 | 1.05 |
| Yugoslavia | 0.39 | 0.15 | 1.03 | 0.38 | 0.14 | 1.01 | 0.39 | 0.15 | 1.05 |
| Romania | 0.87 | 0.33 | 2.31 | 0.90 | 0.34 | 2.39 | 0.79 | 0.30 | 2.10 |
| Baltic countries | 0.90 | 0.77 | 1.06 | 0.92 | 0.78 | 1.09 | 0.91 | 0.78 | 1.08 |

Table 3 continued

| | Model 1 | | | Model 2 | | | Model 3 | | |
|-----------------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| | HR | 95% CI | | HR | 95% CI | | HR | 95% CI | |
| Estonia | 0.88 | 0.74 | 1.05 | 0.90 | 0.75 | 1.08 | 0.88 | 0.74 | 1.06 |
| Latvia | 1.03 | 0.69 | 1.54 | 1.06 | 0.71 | 1.58 | 1.12 | 0.75 | 1.67 |
| Central Europe | 0.71 | 0.54 | 0.93 | 0.72 | 0.55 | 0.94 | 0.68 | 0.52 | 0.90 |
| Poland | 0.83 | 0.58 | 1.19 | 0.83 | 0.58 | 1.19 | 0.79 | 0.55 | 1.12 |
| Other Central Europe | 0.42 | 0.21 | 0.83 | 0.42 | 0.21 | 0.84 | 0.41 | 0.20 | 0.82 |
| Hungary | 0.79 | 0.47 | 1.34 | 0.80 | 0.47 | 1.35 | 0.77 | 0.46 | 1.30 |
| Africa | 0.90 | 0.29 | 2.79 | 0.93 | 0.30 | 2.89 | 1.27 | 0.41 | 3.95 |
| North America | 0.84 | 0.70 | 1.00 | 0.84 | 0.71 | 1.00 | 0.87 | 0.73 | 1.04 |
| Latin America | 0.48 | 0.12 | 1.92 | 0.49 | 0.12 | 1.94 | 0.60 | 0.15 | 2.38 |
| Asia | 0.50 | 0.22 | 1.11 | 0.51 | 0.23 | 1.14 | 0.53 | 0.24 | 1.18 |
| Other Asian countries | 0.57 | 0.24 | 1.36 | 0.59 | 0.25 | 1.42 | 0.64 | 0.26 | 1.53 |
| Russia | 1.04 | 0.81 | 1.34 | 1.05 | 0.82 | 1.36 | 0.99 | 0.77 | 1.28 |

Model 1 was adjusted for age and region of residence in Sweden; Model 2 was adjusted for age, region of residence in Sweden, educational level, marital status and neighbourhood SES; Model 3 was constructed as Model 2 with inclusion of co-morbidities

Significant values HRs and 95% CIs marked by bold

Middle East and Africa [24]. On a global scale, hypertension is more prevalent in Central and Eastern Europe and also in Sub-Saharan Africa and South Asia [25] but we found no increased AF incidence among most Central or Eastern European immigrants. In Europe, hypertension is more common among immigrants from Sub-Saharan Africa and South Asia but is less common among immigrants from Middle-eastern countries [26]. In Sweden, hypertension has been found to be lower among immigrants of non-European origin [27], i.e. among immigrants with lower AF risks than Swedish-born individuals and higher among Finnish immigrants. In Bosnians, the risk of cardiovascular disorder (including CHD) has been shown to be increased in both women and men [28], which may partly explain their increased AF incidence as many risk factors are common for both conditions. In contrast to hypertension, the diabetes prevalence has been shown to be higher among immigrants of Middle Eastern origin, especially females, than immigrants from the Nordic countries [29]. This could possibly be linked to the increased AF incidence among Iraqi women. There are also contradictory findings in the literature regarding the relation between traditional cardiovascular risk factors and AF, e.g. a lower rate of AF among South Asians in the UK despite an adverse cardiovascular risk factor profile [14], and a higher AF risk among non-Hispanic whites in the US compared to non-Hispanic blacks, Chinese and Hispanics despite a lower prevalence of hypertension [11].

Dietary factors could be of importance for the development of AF [30]. For instance, the Mediterranean diet in the South European countries is associated with a lower risk of CHD [31] and intake of olive oil has also been

associated with a lower AF risk [32]. In addition, high intake of fish with high levels of omega-3 fatty acids has also been found to prevent AF in some studies [33]. This association may possibly explain the lower AF incidence among Icelandic immigrants, even if the total evidence for this is inconclusive [34]. Otherwise, the lower AF incidence among immigrants from Iceland and Southern Europe could be attributed to their diet, which is high in marine food. Contradictory to this, incidence of AF on Iceland has increased during recent years [35]. Some of the other risk factors for AF, such as smoking [23] and high alcohol intake [30], seemed to be of minor importance to the AF incidence in the present study.

The healthy migrant effect, i.e. more healthy subjects tend to migrate [36], could be one important factor explaining the lower incidence of AF among first-generation immigrants, as more well-educated people migrate to Sweden from both Western and non-Western countries. However, in contrast to most Nordic neighbouring countries, immigrants from the Baltic countries, some Eastern European countries, and to some extent also Finland, tend to belong to the labour force group of immigrants. One Finnish twin study found that the twin who migrated to Sweden tended to have more cardiovascular risk factors than the non-migrant twin [37].

A novel finding in our study is the higher AF incidence in some groups with a high rate of war refugees to Sweden, e.g. from Bosnia during the 1990s and from Iraq after the turn of the millennium. Refugees may have experienced many stressful events, both before and during the migration, and stress has been shown to be associated with AF [38]. The concept of allostasis, i.e. the physiological

response to acute stress [39] and of allostatic load, i.e. the accumulated side effects of life-course stress is thus of relevance; allostatic load is connected with the development of cardiovascular risk factors [40]. Thus, experiencing stressful events could possibly partially explain the higher AF incidence among male and female immigrants from Bosnia and female immigrants from Iraq. Another possibility is that refugees seek hospital care more frequently and will thus be more often examined and diagnosed with AF.

In addition to the more commonly recognised individual factors, socioeconomic factors are also of importance; lower family income and lower educational status have been shown to increase the risk of AF [41]. We also adjusted for neighbourhood-level SES as many immigrants, especially from non-Western countries, live in low SES neighbourhoods in urban areas. Living in low SES neighbourhoods is associated with an increased morbidity risk of AF-associated diagnoses [42], including cardiovascular health [16] and diabetes [43]. The mobility of individuals between different neighbourhoods is rather small [17].

The AF incidence pattern among second-generation immigrants differed in most cases only marginally compared to their Swedish-born counterparts with two Swedish-born parents, possibly due to acculturation, i.e. second-generation immigrants tend to adopt the lifestyle and health patterns of the host population over time and have a tendency to develop AF at the same rate.

A relevant question to ask is whether it is possible in the present study to recognise the finding in earlier studies that the health of immigrants tends to decline with years living in the new country [9, 10]. However, considering the diversity of the results in the different immigrant groups in the present study, as well as the diversity of the countries of origin of the immigrants, we judge that the results from such an analysis would be difficult to interpret.

This study has certain limitations. We had no data available on the type of atrial fibrillation (paroxysmal, persistent, or permanent). AF diagnoses were taken from the National Patient Register covering diagnoses from in-hospital patients and specialist open care, as data from primary care were not available to us. According to the data from Stockholm County this would cover 68% of all AF patients [5]. However, we consider a hospital diagnosis of AF to be of higher validity than a primary care diagnosis. Given that our focus was predominantly on cardiovascular co-morbidity and whether the relationship between neighbourhood SES and all-cause mortality is independent of cardiovascular comorbidity, we did not include other potential diagnoses associated with mortality such as presence of cancer or other non-cardiovascular medical prescriptions. In addition, we did not have access to multiple measures of individual SES.

However, we adjusted our analyses for level of formal education, which is a commonly used proxy for individual SES [44]. As we explored multiple immigrant groups, there is a risk of mass significance due to multiple testing. We also performed a sensitivity analysis excluding subjects that had arrived in Sweden during the last five years. The statistical power to detect significant results also differed between the immigrant groups owing to varying sample sizes, and the power was lower among women, especially second-generation women.

Despite the limitations, one of the key strengths of this study is the linkage of clinical data (less than 1% missing data) from individual patients to national demographic and socioeconomic data. The clinical data were also highly complete; less than 2% of the total number of diagnoses were missing [45]. The comprehensive nature of our data made it possible to analyse men and women from all types of sociodemographic backgrounds.

In conclusion, we found an increased incidence of AF among certain immigrant groups, especially among immigrants from some war-torn regions, and a lower incidence among immigrant groups from countries with a traditionally healthy diet. From a clinical point of view, it is important to be aware of the increased incidence of AF in some immigrant groups in order to enable for a timely diagnosis, treatment and prevention of debilitating complications associated with AF, such as ischaemic stroke.

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Compliance with ethical standards

Conflict of interest Dr. Holzmann received consultancy honoraria from Pfizer and Actelion. The other authors have no conflict of interest to disclose.

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References

1. Hobbs FR, Taylor CJ, Jan Geersing G, Rutten FH, Brouwer JR. European Primary Care Cardiovascular Society (EPCCS)

- consensus guidance on stroke prevention in atrial fibrillation (SPAF) in primary care. *Eur J Prev Cardiol.* 2015;. doi:[10.1177/2047487315571890](https://doi.org/10.1177/2047487315571890).
2. Wann LS, Curtis AB, Ellenbogen KA, et al. Management of patients with atrial fibrillation (compilation of 2006 ACCF/AHA/ESC and 2011 ACCF/AHA/HRS recommendations): a report of the American College of Cardiology/American Heart Association Task Force on practice guidelines. *Circulation.* 2013;127(18):1916–26. doi:[10.1161/CIR.0b013e318290826d](https://doi.org/10.1161/CIR.0b013e318290826d).
 3. Chugh SS, Havmoeller R, Narayanan K, et al. Worldwide epidemiology of atrial fibrillation: a Global Burden of Disease 2010 Study. *Circulation.* 2014;129(8):837–47. doi:[10.1161/CIRCULATIONAHA.113.005119](https://doi.org/10.1161/CIRCULATIONAHA.113.005119).
 4. Rahman F, Kwan GF, Benjamin EJ. Global epidemiology of atrial fibrillation. *Nat Rev Cardiol.* 2014;11(11):639–54. doi:[10.1038/nrcardio.2014.118](https://doi.org/10.1038/nrcardio.2014.118).
 5. Forslund T, Wettermark B, Wandell P, von Euler M, Hasselstrom J, Hjemdahl P. Risk scoring and thromboprophylactic treatment of patients with atrial fibrillation with and without access to primary healthcare data: experience from the Stockholm health care system. *Int J Cardiol.* 2013;170(2):208–14. doi:[10.1016/j.ijcard.2013.10.063](https://doi.org/10.1016/j.ijcard.2013.10.063).
 6. Zoni-Berisso M, Lercari F, Carazza T, Domenicucci S. Epidemiology of atrial fibrillation: European perspective. *Clin Epidemiol.* 2014;6:213–20. doi:[10.2147/CLEP.S47385](https://doi.org/10.2147/CLEP.S47385).
 7. Friberg L, Bergfeldt L. Atrial fibrillation prevalence revisited. *J Intern Med.* 2013;274(5):461–8. doi:[10.1111/joim.12114](https://doi.org/10.1111/joim.12114).
 8. Foreign-born persons in Sweden by country of birth, age and sex. Year 2000–2015 [database on the Internet]. Statistics Sweden. 2016. http://www.statistikdatabasen.scb.se/pxweb/sv/ssd/START_BE_BE0101_BE0101E/UtrikesFoddar/?rxid=b4a34c1b-bd89-4621-8bd4-606c8809678a.
 9. Antecol H, Bedard K. Unhealthy assimilation: why do immigrants converge to American health status levels? *Demography.* 2006;43(2):337–60.
 10. De Maio FG, Kemp E. The deterioration of health status among immigrants to Canada. *Glob Public Health.* 2010;5(5):462–78. doi:[10.1080/17441690902942480](https://doi.org/10.1080/17441690902942480).
 11. Rodriguez CJ, Soliman EZ, Alonso A, et al. Atrial fibrillation incidence and risk factors in relation to race-ethnicity and the population attributable fraction of atrial fibrillation risk factors: the Multi-Ethnic Study of Atherosclerosis. *Ann Epidemiol.* 2015;25(2):71–6. doi:[10.1016/j.annepidem.2014.11.024](https://doi.org/10.1016/j.annepidem.2014.11.024).
 12. Golwala H, Jackson LR 2nd, Simon DN, et al. Racial/ethnic differences in atrial fibrillation symptoms, treatment patterns, and outcomes: insights from Outcomes Registry for Better Informed Treatment for Atrial Fibrillation Registry. *Am Heart J.* 2016;174:29–36. doi:[10.1016/j.ahj.2015.10.028](https://doi.org/10.1016/j.ahj.2015.10.028).
 13. Gbadebo TD, Okafor H, Darbar D. Differential impact of race and risk factors on incidence of atrial fibrillation. *Am Heart J.* 2011;162(1):31–7. doi:[10.1016/j.ahj.2011.03.030](https://doi.org/10.1016/j.ahj.2011.03.030).
 14. Gillott RG, Willan K, Kain K, Sivananthan UM, Tayebjee MH. South Asian ethnicity is associated with a lower prevalence of atrial fibrillation despite greater prevalence of established risk factors: a population-based study in Bradford Metropolitan District. *Europace.* 2016;. doi:[10.1093/europace/euw010](https://doi.org/10.1093/europace/euw010).
 15. Ludvigsson JF, Andersson E, Ekblom A, et al. External review and validation of the Swedish national inpatient register. *BMC Public Health.* 2011;11:450. doi:[10.1186/1471-2458-11-450](https://doi.org/10.1186/1471-2458-11-450).
 16. Winkleby M, Sundquist K, Cubbin C. Inequities in CHD incidence and case fatality by neighborhood deprivation. *Am J Prev Med.* 2007;32(2):97–106. doi:[10.1016/j.amepre.2006.10.002](https://doi.org/10.1016/j.amepre.2006.10.002).
 17. Zoller B, Li X, Sundquist J, Sundquist K. Neighbourhood deprivation and hospitalization for atrial fibrillation in Sweden. *Europace.* 2013;15(8):1119–27. doi:[10.1093/europace/eut019](https://doi.org/10.1093/europace/eut019).
 18. Chugh SS, Roth GA, Gillum RF, Mensah GA. Global burden of atrial fibrillation in developed and developing nations. *Glob Heart.* 2014;9(1):113–9. doi:[10.1016/j.gheart.2014.01.004](https://doi.org/10.1016/j.gheart.2014.01.004).
 19. Schmitt J, Duray G, Gersh BJ, Hohnloser SH. Atrial fibrillation in acute myocardial infarction: a systematic review of the incidence, clinical features and prognostic implications. *Eur Heart J.* 2009;30(9):1038–45. doi:[10.1093/eurheartj/ehn579](https://doi.org/10.1093/eurheartj/ehn579).
 20. Anumonwo JM, Kalifa J. Risk factors and genetics of atrial fibrillation. *Heart Fail Clin.* 2016;12(2):157–66. doi:[10.1016/j.hfc.2015.08.013](https://doi.org/10.1016/j.hfc.2015.08.013).
 21. Manolis AJ, Rosei EA, Coca A, et al. Hypertension and atrial fibrillation: diagnostic approach, prevention and treatment. Position paper of the Working Group ‘Hypertension Arrhythmias and Thrombosis’ of the European Society of Hypertension. *J Hypertens.* 2012;30(2):239–52. doi:[10.1097/HJH.0b013e32834f03bf](https://doi.org/10.1097/HJH.0b013e32834f03bf).
 22. Asghar O, Alam U, Hayat SA, Aghamohammadzadeh R, Heagerty AM, Malik RA. Obesity, diabetes and atrial fibrillation; epidemiology, mechanisms and interventions. *Curr Cardiol Rev.* 2012;8(4):253–64.
 23. Chamberlain AM, Agarwal SK, Folsom AR, et al. Smoking and incidence of atrial fibrillation: results from the Atherosclerosis Risk in Communities (ARIC) study. *Heart Rhythm.* 2011;8(8):1160–6. doi:[10.1016/j.hrthm.2011.03.038](https://doi.org/10.1016/j.hrthm.2011.03.038).
 24. Oldgren J, Healey JS, Ezekowitz M, et al. Variations in cause and management of atrial fibrillation in a prospective registry of 15,400 emergency department patients in 46 countries: the RE-LY Atrial Fibrillation Registry. *Circulation.* 2014;129(15):1568–76. doi:[10.1161/CIRCULATIONAHA.113.005451](https://doi.org/10.1161/CIRCULATIONAHA.113.005451).
 25. Worldwide trends in blood pressure from 1975 to 2015: a pooled analysis of 1479 population-based measurement studies with 19.1 million participants. *Lancet.* 2017; 389(10064):37–55. doi:[10.1016/S0140-6736\(16\)31919-5](https://doi.org/10.1016/S0140-6736(16)31919-5).
 26. Modesti PA, Reboldi G, Cappuccio FP, et al. Panethnic differences in blood pressure in Europe: a systematic review and meta-analysis. *PLoS ONE.* 2016;11(1):e0147601. doi:[10.1371/journal.pone.0147601](https://doi.org/10.1371/journal.pone.0147601).
 27. Carlsson AC, Wandell PE, de Faire U, Hellenius ML. Prevalence of hypertension in immigrants and Swedish-born individuals, a cross-sectional study of 60-year-old men and women in Sweden. *J Hypertens.* 2008;26(12):2295–302.
 28. Gadd M, Johansson SE, Sundquist J, Wandell P. Morbidity in cardiovascular diseases in immigrants in Sweden. *J Intern Med.* 2003;254(3):236–43.
 29. Wandell PE, Carlsson A, Steiner KH. Prevalence of diabetes among immigrants in the Nordic countries. *Curr Diabetes Rev.* 2010;6(2):126–33.
 30. Gronroos NN, Alonso A. Diet and risk of atrial fibrillation—epidemiologic and clinical evidence. *Circ J.* 2010;74(10):2029–38.
 31. Kastorini CM, Milionis HJ, Goudevenos JA, Panagiotakos DB. Mediterranean diet and coronary heart disease: is obesity a link?—a systematic review. *Nutr Metab Cardiovasc Dis.* 2010;20(7):536–51. doi:[10.1016/j.numecd.2010.04.006](https://doi.org/10.1016/j.numecd.2010.04.006).
 32. Martinez-Gonzalez MA, Toledo E, Aros F, et al. Extravirgin olive oil consumption reduces risk of atrial fibrillation: the PREDIMED (Prevencion con Dieta Mediterranea) trial. *Circulation.* 2014;130(1):18–26. doi:[10.1161/CIRCULATIONAHA.113.006921](https://doi.org/10.1161/CIRCULATIONAHA.113.006921).
 33. Rix TA, Joensen AM, Riahi S, et al. A U-shaped association between consumption of marine n-3 fatty acids and development of atrial fibrillation/atrial flutter—a Danish cohort study. *Europace.* 2014;16(11):1554–61. doi:[10.1093/europace/euu019](https://doi.org/10.1093/europace/euu019).
 34. Christou GA, Christou KA, Korantzopoulos P, Rizos EC, Nikas DN, Goudevenos JA. The current role of omega-3 fatty acids in

- the management of atrial fibrillation. *Int J Mol Sci.* 2015;16(9):22870–87. doi:[10.3390/ijms160922870](https://doi.org/10.3390/ijms160922870).
35. Stefansdottir H, Aspelund T, Gudnason V, Arnar DO. Trends in the incidence and prevalence of atrial fibrillation in Iceland and future projections. *Europace.* 2011;13(8):1110–7. doi:[10.1093/europace/eur132](https://doi.org/10.1093/europace/eur132).
 36. Diaz E, Kumar BN. Differential utilization of primary health care services among older immigrants and Norwegians: a register-based comparative study in Norway. *BMC Health Serv Res.* 2014;14:623. doi:[10.1186/s12913-014-0623-0](https://doi.org/10.1186/s12913-014-0623-0).
 37. Silventoinen K, Hammar N, Hedlund E, Koskenvuo M, Ronnema T, Kaprio J. Selective international migration by social position, health behaviour and personality. *Eur J Public Health.* 2008;18(2):150–5. doi:[10.1093/eurpub/ckm052](https://doi.org/10.1093/eurpub/ckm052).
 38. Graff S, Fenger-Grøn M, Christensen B, et al. Long-term risk of atrial fibrillation after the death of a partner. *Open Heart.* 2016;3:e000367. doi:[10.1136/openhrt-2015-000367](https://doi.org/10.1136/openhrt-2015-000367).
 39. McEwen BS. Allostasis and allostatic load: implications for neuropsychopharmacology. *Neuropsychopharmacology.* 2000;22(2):108–24. doi:[10.1016/S0893-133X\(99\)00129-3](https://doi.org/10.1016/S0893-133X(99)00129-3).
 40. Seeman TE, Singer BH, Rowe JW, Horwitz RI, McEwen BS. Price of adaptation—allostatic load and its health consequences. *MacArthur studies of successful aging. Arch Intern Med.* 1997;157(19):2259–68.
 41. Misialek JR, Rose KM, Everson-Rose SA, et al. Socioeconomic status and the incidence of atrial fibrillation in whites and blacks: the Atherosclerosis Risk in Communities (ARIC) study. *J Am Heart Assoc.* 2014;. doi:[10.1161/JAHA.114.001159](https://doi.org/10.1161/JAHA.114.001159).
 42. Pickering T. Cardiovascular pathways: socioeconomic status and stress effects on hypertension and cardiovascular function. *Ann N Y Acad Sci.* 1999;896:262–77.
 43. White JS, Hamad R, Li X, et al. Long-term effects of neighbourhood deprivation on diabetes risk: quasi-experimental evidence from a refugee dispersal policy in Sweden. *Lancet Diabetes Endocrinol.* 2016;. doi:[10.1016/S2213-8587\(16\)30009-2](https://doi.org/10.1016/S2213-8587(16)30009-2).
 44. Winkleby MA, Jatulis DE, Frank E, Fortmann SP. Socioeconomic status and health: how education, income, and occupation contribute to risk factors for cardiovascular disease. *Am J Public Health.* 1992;82(6):816–20.
 45. Sundquist K, Chaikiat A, Leon VR, Johansson SE, Sundquist J. Country of birth, socioeconomic factors, and risk factor control in patients with type 2 diabetes: a Swedish study from 25 primary health-care centres. *Diabetes Metab Res Rev.* 2011;27(3):244–54. doi:[10.1002/dmrr.1161](https://doi.org/10.1002/dmrr.1161).