International Journal of Cardiology 202 (2016) 776–781

Contents lists available at ScienceDirect

International Journal of Cardiology

journal homepage: www.elsevier.com/locate/ijcard

Neighbourhood socio-economic status and all-cause mortality in adults with atrial fibrillation: A cohort study of patients treated in primary care in Sweden

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ARTICLE INFO

Article history:
Received 16 April 2015
Received in revised form 31 August 2015
Accepted 19 September 2015
Available online 21 September 2015

Keywords:
Neighbourhood
Atrial fibrillation
Mortality
Gender
Follow-up
Co-morbidity
Antithrombotic drugs

ABSTRACT

Objective: Our aim was to study the potential impact of neighbourhood socio-economic status (SES) on all-cause mortality in patients with atrial fibrillation (AF) treated in primary care.
Methods: Study population included adults (n = 12,283) of 45 years and older diagnosed with AF in 75 primary care centres in Sweden. Association between neighbourhood SES and all-cause mortality was explored using Cox regression analysis, with hazard ratios (HRs) and 95% confidence intervals (95% CIs), and by Laplace regression where years to death (95% CI) of the first 10% of the participants were used as an outcome. All models were conducted in both men and women and adjusted for age, educational level, marital status, change of neighbourhood status, cardiovascular co-morbidities, anticoagulant treatment and statin treatment. High- and low-neighbourhood SES were compared with middle SES as reference group.
Results: After adjustments for potential confounders, higher relative risk of all-cause mortality (HR 1.49, 95% CI 1.13–1.96) was observed in men living in low SES neighbourhoods compared to those from middle SES neighbourhoods. The results were confirmed using Laplace regression; the time until the first 10% of the men in low SES neighbourhoods died was 1.45 (95% CI 0.48–2.42) years shorter than for the men in middle SES neighbourhoods.
Conclusions: Increased rates of heart disease and subsequent mortality among adults in deprived neighbourhoods raise important clinical and public health concerns. These findings could serve as an aid to policy-makers when allocating resources in primary health care settings as well as to clinicians who encounter patients in deprived neighbourhoods.

1. Introduction

Atrial fibrillation (AF) is the most common form of arrhythmia in humans, and, if left untreated, it is associated with significant morbidity, especially from stroke [1,2]. The prevalence of atrial fibrillation is about 2% in the Swedish population [3]. The lifetime risk to develop atrial fibrillation from 40 years of age and older, around one out of four, is similar for men and women [4]. However, men have a 1.5-fold higher risk of developing atrial fibrillation compared to women, when adjusted for age and predisposing conditions [5]. Adjusting for age is important, since men develop atrial fibrillation around five years earlier than women do [6].

Patients with atrial fibrillation are found to have an excess mortality compared to individuals without atrial fibrillation [7]. The excess mortality is 50% higher in men and 100% higher in women [8]. The higher mortality risk in women may partly be explained by a higher risk for stroke than in men [7].

Many atrial fibrillation patients in Sweden receive medical care at primary health care centres, and in Stockholm County, 64% of the atrial fibrillation patients had an AF diagnosis registered in primary care [3]. We have previously investigated mortality among Swedish men and women with atrial fibrillation in primary care, and observed a decreased mortality related to treatment with certain cardio-vascular drugs, especially anticoagulants [9]. Among medications, anticoagulant treatment plays a significant role [10], not only in stroke-prevention but also in preventing myocardial infarction [11], and decreasing mortality [12].

In addition to individual factors, such as age, gender and other predisposing conditions for atrial fibrillation, it is also important to consider the potential impact of environmental factors on atrial fibrillation. For

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http://dx.doi.org/10.1016/j.ijcard.2015.09.027
0167-5273/

example, neighbourhood SES has been found to be associated with overall health [13], cardiovascular health [14,15], and all-cause mortality [16,17]. A previous study found an association between neighbourhood SES and hospitalization of atrial fibrillation patients in women that no longer remained significant after adjustment for individual factors [18]. However, no studies to date have described the possible association between neighbourhood SES and mortality in atrial fibrillation patients. Herein, the objective of our study was to explore the potential effect of neighbourhood SES on all-cause mortality in men and women diagnosed with atrial fibrillation and to evaluate whether this relationship is independent of factors known to influence mortality in atrial fibrillation, such as age, cardiovascular co-morbidities, as well as marital status and educational level. We hypothesize that all-cause mortality among patients with atrial fibrillation is higher in neighbourhoods with lower SES than in neighbourhoods with higher SES and that this is independent of potential confounders.

2. Methods

2.1. Design

This study was performed using individual-level patient data from 75 Swedish primary health care centres (PHCC). The majority was located in Stockholm County (n = 48). Men and women visiting any of the participating PHCCs between 2001 and 2007 were included in the study. We used *Extractor* software (http://www.slso.sll.se/SLPOtemplates/SLPOPage1____10400.aspx; accessed September 19, 2010) to collect individual files from the electronic patient records (EPR) at the PHCCs. Individual identification numbers were replaced by serial numbers to ensure anonymity. The EPR files were linked to a database constructed using Swedish national registers [19]. The registers used were: the Total Population register (which contains data on, e.g., age and education for the entire population of Sweden); the Inpatient Register (hospital admissions); and the Cause of Death Register. These registers contain individual-level population data for all residents registered in Sweden. Thus, a new research database was created, containing individual clinical patient data from a total of 1,098,420 subjects registered at these 75 PHCCs, linked to national demographic and socioeconomic data. Follow-up was performed using the Swedish Cause of Death Register, which has been shown to be almost complete, 99.8%, and lacking data only for a few emigrants from Sweden to other countries and thus lost to follow-up [20].

2.2. Study population and co-morbidities

The study included all patients with diagnosed atrial fibrillation, identified by the presence of the ICD-10 code (10th version of the WHO's International Classification of Diseases) for atrial fibrillation (I48) in patients' medical records. The following related cardiovascular disorders were used as covariates: hypertension (I10-15), coronary heart disease (CHD; I20-25), cardiac heart failure (CHF; I50 and I110), non-rheumatic valvular diseases (I34-38), cardiomyopathy (I42), cerebrovascular diseases (CVD; I60-69), including intracranial bleedings (I60-62), and peripheral embolism (I74). In addition, presence of diabetes mellitus (E10-14) was also recorded. In total, 6646 men and 5637 women ≥45 years of age at the time of atrial fibrillation diagnosis who visited any of the 75 participating PHCCs from 1 January 2001 until 31 December 2007 and with data on neighbourhood socioeconomic status were included in the study [9].

2.3. Outcome variable

Time to death during the assessment period (from registration of the atrial fibrillation diagnosis to December 31, 2007).

2.4. Demographic and socio-economic variables

Sex: men and women.

Age was categorized as follows: 45–54, 55–64, 65–74, 75–84 and >85 years. Individuals younger than 45 years were excluded (atrial fibrillation was rare in individuals below 45 years of age and non-representative of atrial fibrillation patients in general).

Educational attainment was categorized 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).

2.5. Neighbourhood socio-economic status

The neighbourhoods were derived from Small Area Market Statistics (SAMS), which 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 to 64 years 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 categorized 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 deprivation level), [15] with neighbourhood status classified as high, middle or low SES, or on low, middle and high deprivation index [18].

2.6. Statistical analysis

Baseline subject characteristics across neighbourhood SES were presented as mean (SD) if continuous and as frequencies if categorical, and differences were calculated by ANOVA or chi-square test. Test for trends was performed by Cuzick's non-parametric test. The potential effects of neighbourhood SES on mortality in adults diagnosed with atrial fibrillation were evaluated using Cox-proportional hazards modelling. Before running the regression models, variables were tested for interactions. The only significant one was between age and diabetes in men ($p = 0.041$), which we added to the models. The following four models were created: 1) Model A: neighbourhood SES (high, middle or low) and age group; 2) Model B: Model A and educational attainment (compulsory school, secondary school or college/university) and marital status (married, unmarried, divorced or widowed); 3) Model C: Model B and change of residence according to neighbourhood status (higher to lower, lower to higher, or no change of neighbourhood SES level), as well as comorbidities (hypertension, coronary heart disease, heart failure, cerebrovascular disease and diabetes) and possible interaction terms (only age group x diabetes for men); and 4) Model D: Model C and prescribed anticoagulant treatment and statins. The effects of neighbourhood SES on mortality were also assessed by Laplace regression by applying the same models as described above. Laplace regression was used to calculate the difference in years until death of the first 10% of the participants in the different socioeconomic neighbourhood groups, using the middle group as reference [21,22]. Since different distributions and mathematical calculations are used to obtain results in Cox and Laplace regression, respectively, putting emphasis on findings significant with both methods may reduce the risk of chance findings [23]. Analyses were performed separately for men and women. *p*-Values of <0.05 were considered statistically significant. The study was approved by the regional ethics boards at Karolinska Institutet and Lund University.

3. Results

The mean follow-up time was 3.5 years (standard deviation 2.1) and the median follow-up time 3.5 years (95% CI 3.5–3.5; interquartile range 1.5–5.5). The calculated hazard ratios were based on a total of 42,907 person-years at risk, 23,234 person-years among men and 19,673 among women. A total of 701 men and 744 women died during follow-up, 10.5% vs. 13.2% ($p < 0.001$). Many men and women changed their place of residence during the follow-up. Some moved from neighbourhoods of higher to those of lower SES (men 1861 (28.0%) and women 1564 (27.8%)); and others moved from lower SES neighbourhoods to higher SES neighbourhoods (men 712 (10.7%) and women 625 (11.1%)). The remaining 4073 (61.3%) men and 3448 (61.2%) women did not change their place of residence during the study.

Table 1 presents the characteristics of the 6,646 men and 5,637 women included in the study. In men and women, percent of individuals being married, and those with higher levels of formal education increased when neighbourhood SES increased. Furthermore, rates of unmarried and divorced men decreased when neighbourhood SES increased. In contrast, the prevalence of comorbidities including hypertension, coronary heart disease, heart failure and diabetes decreased when neighbourhood SES increased.

The potential effects of neighbourhood SES on all-cause mortality are presented in Table 2 (Cox proportional-hazards regression models), and Table 3 (Laplace regression models). After adjustment for age group, educational level, marital status, change of neighbourhood status, and cardiovascular co-morbidity, a higher relative risk of all-cause mortality (HR 1.49, 95% CI 1.13–1.96) was observed in men living in low SES neighbourhoods compared to those from middle SES neighbourhoods (Table 2). The potential effects of neighbourhood deprivation on all-cause mortality was slightly attenuated after adjustment for prescription of anticoagulants and statins, but remained statistically